Not on Index 1/83

UNITED NATIONS

ECONOMIC AND SOCIAL COUNCIL

Distr.
GENERAL

E/CN.14/757
ECA/NRD/CESTD/80/WP.3
18 February 1980

Original: ENGLISH

ECONOMIC COMMISSION FOR AFRICA

Intergovernmental Committee of Experts for Science and Technology Development

Addis Ababa, Ethiopia - 10 to 15 March 1980

ECONOMIC COMMISSION FOR AFRICA

First Meeting of the Technical Preparatory Committee of the Whole

Addis Ababa, 3 to 8 April 1980

ECONOMIC COMMISSION FOR AFRICA

Fifteenth session of the Commission/
Sixth Meeting of the Conference of Ministers

MOBILIZING SCIENCE AND TECHNOLOGY FOR DEVELOPMENT IN AFRICA: STRATEGY AND DYNAMIC ACTION PROGRAMME FOR THE 1980s AND BEYOND

80-403

PART I

INTRODUCTION

1. The decision to convene a United Nations Conference on Science and Technology for Development in 1979 was taken by the General Assembly, at its seventh special session, in its resolution 3362 (S-VII) of 16 September 1975. It was based on discussions in the Advisory Committee for Application of Science and Technology to Development, the Committee on Science and Technology for Development and the Economic and Social Council.

2. At the end of the First United Nations Development Decade, the General Assembly adopted resolution 2658 (XXV) of 7 December 1970 in which it requested the Secretary-General to evaluate the main implications of modern science and technology, particularly for development and to appraise the results achieved by the United Nations system in promoting science and technology and their application to development from 1963 to the present. In his report (E/5238 and Add.1/Corr.1) submitted in response to this request, the Secretary-General expressed the view that, although the 1963 Conference 1/ had created an awareness of the importance of science and technology in the process of development, this had not been followed by the expected action. He accordingly recommended that the Committee on Science and Technology for Development should give serious thought to the question of generating the necessary political will and action, and should consider the merits of holding an international conference to focus on policies and practical courses of action at the national and international levels (see E/5238, para. 22).

3. Subsequently, in resolution 1897 (LVII) of 1 August 1974, the Economic and Social Council emphasized the necessity for a conference, and recognized that the new needs in the field of science and technology made it imperative for the United Nations to expand international co-operation on the basis of principles designed to adjust the scientific and technological relationships among States in a manner compatible with the special requirements and interests of developing countries.

4. An Intergovernmental Working Group of the Committee on Science and Technology for Development was convened by the Economic and Social Council in 1975 to examine the specific objectives, topics and agenda for a United Nations Conference, based on the recommendations of the Advisory Committee on the Application of Science and Technology to Development, the Intergovernmental Group on Transfer of Technology of the United Nations Conference on Trade and Development, the regional Commissions and other United Nations bodies.

5. At its third session in 1976, the Committee on Science and Technology for Development approved a draft resolution which was subsequently adopted by the Economic and Social Council as resolution 2028 (LVI) of 4 August 1976. This was later endorsed by the General Assembly in resolution 31/184 of 21 December 1976.

1/ The United Nations Conference on Science and Technology for the Benefit of Less Developed Areas.

6. The resolution established a link between the Conference and the new international economic order adopted by the General Assembly at its sixth special session (resolution 3201 /S-VI/ and 3202/S-VI/; it was recommended that science and technology should be called upon to play a more direct and important role in the process of stimulating development and reducing international inequalities as well as inequalities within regions and within countries. The new international economic order is concerned, inter alia, with policies that may enable the developing countries, in co-operation with the developed countries, to redress the imbalance of economic power and provide a new basis for achieving higher living standards through both domestic effort and international solidarity. The role of science and technology in this process is recognized as a vital one.

Objectives of the Conference

7. The Intergovernmental Working Group recommended that the Conference should:

(a) Adopt concrete decisions on ways and means of applying science and technology in establishing a new international economic order as a strategy for economic and social development within a time frame;

(b) Strengthen the technological capacity of developing countries to enable them to apply science and technology to their own development;

(c) Adopt effective means for utilization of the scientific and technological potentials in the solutions of problems of development of national, regional and global significance, especially for the benefit of developing countries;

(d) Provide instruments of co-operation to developing countries in the utilization of science and technology for solving socio-economic problems that cannot be solved by an individual section in accordance with national priorities.

Agenda for the Conference

8. The following draft agenda was suggested by the Economic and Social Council in resolution 2028 (LXI) and was adopted with elaborations under each item:

(a) Science and Technology for Development;

(b) Institutional arrangements and new forms of international co-operation in the application of science and technology;

(c) Utilization of the existing United Nations system and other international organizations;

(d) Science and Technology and the Future.

9. A limited number of subject areas were to be selected with the objective that they would:

(a) be few and not exceed five;

(b) be defined as problem areas with economic and social implications that may be solved by utilizing science and technology;

(c) require an integrated and inter-agency interdisciplinary approach;

(d) have clear relevance to problems of development in countries, especially developing countries, and emerge from national priorities through regional consensus;

(e) be clearly delineated and limited in scope.

Preparatory period

10. The preparatory Committee for the United Nations Conference on Science and Technology for Development requested each State to prepare a single national paper which would include the identification of goals, policies, priorities and recommendations dealing with the application of science and technology to development at the national, regional and global levels in accordance with the agenda of the Conference given above. The national papers were to be completed and submitted to the Conference secretariat by 1 May 1978.

11. It was decided by the Committee that the preparatory period for the Conference should form a component of the Conference itself, through national and regional analyses of problems which may be solved with the help of science and technology. This period was to be divided into four stages:

(a) Preparations at the national level;

(b) Activities at the regional level;

(c) Interregional meetings;

(d) Preparations at the international level through the preparatory committee meetings.

12. The work of the ECA secretariat during the preparatory period in the African region was conducted under the guidance of the ECA Steering Committee on UNCSTD and the Science and Technology Unit of the Natural Resources Division.

13. ECA collaborated fully with the UNCSTD secretariat in New York in the execution of preparatory activities for which the UNCSTD secretariat had provided resources including two regional advisers, consultants, a co-ordinator and a bilingual secretary, as well as expenses for pre-session and post-session documentation for the African Regional Meeting.

14. Prior to the holding of African Regional Meeting the activities of the ECA were charted under guidelines set by the General Assembly of the United Nations and by the Intergovernmental Meeting of African Experts on Aspects of Technology Development which was held in Arusha, United Republic of Tanzania from 3 to 8 October 1977. This meeting took decisions as to the nature and organization of the African Regional Meeting and other preparatory activities. 2/

15. As a result of these decisions, ECA mounted several missions to various African countries, attended and actively participated in national seminars and subregional expert group meetings, and prepared the draft of a regional paper 3/ based on contributions made by various United Nations bodies, other international organizations, a number of national organizations, Governments of ECA member States, various individuals, a meeting of experts convened at Yaoundé, United Republic of Cameroon, resolutions of IDC experts. The final text of the African Regional Paper was prepared after the draft had been discussed by the African Regional Meeting which was held in Cairo from 24 to 29 August 1978.

16. The African Regional paper commented on the "African science and technology" status quo, and identified the obstacles and bottlenecks in the use of science and technology in Africa. It took cognisance of the fact that although Africa offered a staggering range of challenges where scientific and technological inventions were concerned, the structure of most African economies prevented those challenges from being expressed as effective demands; African countries were heavily dependent on the use of foreign technology; the problem of strengthening domestic technological capabilities, or of reducing technological dependence extended beyond the provision of competent staff and efficient machinery, and was primarily due to lack of capabilities in defining needs in technological terms, in developing technologies appropriate to these needs, and in identifying, selecting, negotiating, installing, operating, maintaining and improving imported technology. A programme of action which was aimed at eliminating the identified obstacles and bottlenecks was proposed.

17. The African Regional Meeting recommended 4/ inter-alia; (i) that efforts should be made by the Executive Secretary of ECA, the Secretary-General of OAU, and executive heads of the competent agencies and organs of the United Nations to continue to facilitate preparations at the national, subregional and regional levels for the major Conference; (ii) the establishment of an adequately funded mechanism for the follow-up and implementation of the programme of action emerging from UNCSTD; and (iii) the restructuring of the ECA Science and Technology Unit to enable it to discharge effectively its increasing responsibilities in the field of science and technology.

18. The preparatory activities mounted by ECA after the African Regional Meeting consisted mainly of participation in the remaining meetings of the

---

2/ E/CN.14/ACTT/6

3/ The draft regional paper was revised after the African Regional Meeting by a group of experts selected by the meeting to assist ECA in preparing the final document in corporating the relevant comments of statement of participants at the meeting - African Regional Paper - E/CN.14/711/Add.1

4/ See E/CN.14/ECO/160, UNCSTD/AFREC/2.

Preparatory Committee on UNCSTD, several symposia 5/ the results of which were intended to be used as inputs to the draft Programme of Action prepared by several sessions of the Preparatory Committee for consideration by the World Conference.

The Conference and its recommendations

19. The World Conference itself was held in Vienna, Austria from 20 to 31 August 1979. It took the form of a negotiation between Third World and developed countries. This approach was a continuation of the procedures which had been adopted by sessions of the Preparatory Committee for the UNCSTD. The Committee prepared a Draft Programme of Action which was the principal document placed before the Conference for consideration.

20. The Draft Programme of Action benefitted minimally from relevant African inputs in the field of science and technology -- shortcoming primarily due to the poor participation of ECA member States in the deliberations of the Preparatory Committee. A further brief analysis of this situation is presented below.

21. The Vienna deliberations, as ultimately embodied in the Vienna Programme of Action of the Conference 6/ recognized that, past development strategies prescribed primarily for developing countries need to be fundamentally changed, if the economic, social and cultural conditions of these countries are to change for the better. It was realized that the primary responsibility for bringing abou this change rested wit the developing countries whose individual and collective efforts, if properly channelled, should eventually ensure economic and technological self-reliance.

22. However, industrial nations, within the framework of international development co-operation in the field of science and technology were expected to assist developing countries in strengthening their innovative capacity and thereby promote their autonomous scientific and technological development.

23. The critical role of financial resources in the application of science and technology to development within this context was also recognized. In addition the need to establish mechanisms to augument the quantum and improve the conditions for the transfer of financial resources for science and technology to developing countries was realized.

24. The United Nations system was critically examined and proposals made for restructuring the organs, organizations and bodies within it.

5/ (a) United Nations Interregional Symposium on the Development Progress and Technological Options in Developing Countries.

(b) The Meeting of African Science and Technology Experts from African LDCs.

(c) The African Regional Symposium on Science and Technology and the Future.

6/ See Chapter VII-A/CONF.81/16. Note that Annex I, which is excluded, contains those texts which were not agreed upon during the deliberations.

25. All these proposals were put together in the Vienna Programme of Action under three major Target Areas:

(a) Strengthening the scientific and technological capacities of developing countries;

(b) Restructuring the existing pattern of international scientific and technological relations;

(c) Strengthening the role of the United Nations in the field of science and technology, and the provision of increased financial resources.

26. In addition, the conference adopted a resolution on Women, science and technology 7/ in which United Nations member States, organs, organizations and other bodies of the United Nations system related to science and technology, the proposed Intergovernmental Committee on Science and Technology for Development and the forthcoming mid-decade conference on women were urged to give due consideration, inter-alia, to the role of women in the decision-making process related to science and technology.

27. The conference also adopted the report of the Working Group on Science and Technology for Development: New Science and Technology for Overcoming Obstacles to Development (Science and Technology and the Future). 8/

Relevance to the African Region of the UNCSTD Recommendations

28. A careful examination of the Vienna Programme of Action reveals the subtle reluctance of the developed countries to meet the substance of the demands of the developing countries as expressed in the objectives of the Conference and in the spirit of the new international economic order, which is concerned, inter-alia with enabling the developing countries in co-operation with the developed countries to redress the imbalance of economic power and provide a new basis for achieving higher standard of living rhrough both domestic effort and international co-operation.

29. The developing countries, realizing that control over "science and technology" invariably granted the holder power to exercise economic political and social control over the non-possesor, and aware that these instruments (science and technology) of development are almost monopolized by a small group of nations and multinationals (which utilize 90 per cent of the world's natural resources owned by a large number of developing countries) sought at the Conference through the draft Programme of Action to challenge the current manner of operation of the economies of the industrialized nations.

30. They proposed 9/, for example, a restructuring of the current distribution of research and development resources which now favours the developed countries by creating a fund based on automatic and predictable contributions from the developed and OPEC countries to finance the science and technology activities of the Third World countries. This proposal came under heavy opposition,

---

7/ Ibid - See Chapter VI, Page 42.

8/ Ibid - See Annex IV - Page 111.

9/ Some of these controversial proposals were in brackets indicating non-agreement during the deliberations of the Preparatory Committee sessions.

from developed countries. The emergent Vienna Programme of Action, is a pot-pourri of old proposals and suggestions addressed to cure a sympton of general issues with no commitment to execution by the developed countries of any concrete programme of action. It avoids the underlying political and other issues peculiar to the development of science and technology in the Third World and necessary for restructuring the old international economic order. It is hard to discern where in the document any significant change from the international status quo has taken place.

31. Third World countries therefore urgently need to address themselves to the socio-economic and political issues governing development, and to devise a strategy or strategies to free themselves from the syndrome of feeding the industrial machines of a few industrialized nations.

32. Africa is no exception to this observation: Its peculiar situation in respect of science and technology development was never fully addressed at the Preparatory Committee sessions or at the Conference. Among the number of reasons for this may be mentioned the following:

(a) The decision to reorganize the originally intended form of the World Conference to that of a negotiation 10/ between third world and developed countries, and the subsequent unrealistic anticipation that the former countries will arrive, if ever at all, at agreed sectoral or specific negotiable positions on such a subject of such vast dimentions, taking into account differences in culture, political orientation and factor proportions, which exist among these third world countries;

(b) Even when it was agreed late in the preparatory period among participating countries that the above strategy should prevail, the African region was severely underrepresented and failed to make the necessary impact at the Preparatory Committee sessions, primarily because several African countries did not field delegations to all the scheduled Committee meetings 11/ for reasons which one would hope were due to lack of resources rather than lack of interest; and when they did, many had not adequately briefed their delegations on the framework of positions they could assume on many of the issues raised; it was further apparent that consultations between and among African delegations had been insufficient.

33. It is evident from the foregoing brief analysis that in spite of the provision of resources for the region by the UNCSTD Secretariat, and the considerable effort put in by the African countries during the preparatory period in staging national seminars, regional meetings, and in preparing national papers

---

10/ Third World Countries were expected to table a "shopping list" of requests for assistance from developed countries on an agreed priority list of pressing science and technology issues.

11/ Some Committee sessions were held in Geneva, others in New York; in several instances, the compositions of the delegations of some African States to these meetings were different and from the ensuing discussions, it was obvious that a delegation attending a previous session of the Committee's deliberations had not adequately briefed its successor. The same observation is true for delegations attending several of the preparatory meetings in the African Region, for example, the African Regional Meeting, the United Nations Interregional Symposium on the Development Progress and Technological Options in Developing Countries, the meeting of African S&T Experts from African LDCs.

and a regional paper, an African position failed to emerge in the VIENNA PROGRAMME OF ACTION; once again an opportunity for formulating realistic and unified African positions on many pressing African development problems was lost.

34. This is a situation which warrants examination by the policy-makers and decision-makers of the continent with a view to mustering the necessary political will and commitment with clearer, more concrete and significant demands when conducting negotiations or holding consultations with the developed countries, international organizations and multinationals to become collectively and individually better strategists and tactician on the national and international scene. Some of the major issues which are of direct and relevant interest to Africa and arround which Africa's effort to bring about a New International Economic Order could be based are highlighted in the ensuing paragraphs.

The aim of the paper

35. This paper represents an attempt to highlight the science and technology issues relevant for the economic and social development of the countries of the African continent within the framework of the African Development Strategy for the next decade and beyond taking into account the relevant sections of the Vienna Programme of Action.

36. After an examination of these issues a programme of action specific and relevant to Africa is presented for consideration.

37. Broad guidelines for the choice of concrete action/actions are presented. Suggestions on possible instruments and/or machinery for implementation are also put forward. The paper is presented in three parts. Part I examines the issues; Part II suggests broad Programme of Action for Africa in science and technology matters and Part III presents some of the problems requiring science and technology solutions in a number of significant sectors.

THE AFRICAN SCENE - MAJOR ISSUES

The Role of Technology in Development

38. A strategy for socio-economic development in any country should aim at improving the quality of life of its inhabitants, and supplying to the greatest extent possible the needs of a majority of the population, while making maximum use of local resources and having due regard for the nature of the local environment.

39. Development can be conceptualized within this context as the change in condition which results from the effort made by man to understand his local environment 12/ and to organize the knowledge thus gained - i.e., science - in a special way by screening, selecting and applying it to a desired goal or goals.

40. A man's quality of life may be considered to be enhanced if he is able to or others can devise for him ways and means to ease the burdens of living in his environment; and this effort successfully resuts in cultivating in him the dignity which emerges from gainful employment, self-confidence, self-

12/ Environment includes the natural resource base.

reliance and in the accumulation of traditional and other knowledge and techniques, methods, procedures, know-how, materials, information and institutions etc., - all being known as technology - and applied to productive use for solving problems.

41. The applied knowledge and techniques etc., enumerated above, under the umbrella of the word technology spread through the society and constitute a root-taking process which is consistent with the citizens' cultural values and social practices. This process is a dynamic one which corresponds to the changing values and systems in the society and which in itself also, contributes to changing local life-styles. It imparts to the individual the fundamental right and ability to develop his capabilities to the fullest extent.

42. The cultural values and social systems of the people within such a society therefore dictate life styles which in turn create demands for products, processes and services i.e., domestic markets and thus influence the choice of technology to satisfy the needs created by these life-styles.

43. There will be occasions within the framework of this concept when some of the knowledge, techniques, information and even raw materials utilized to solve the perceived problems of the local society are external to it. The important observation is that the decision as to how the 'complex' mix of internal and external knowledge, techniques etc...., is to be utilized to satisfy the local needs is made within the society. In addition, the resulting change in condition within the society as the people strive to improve their quality of life is internally directed. Development should therefore result in socio-economic change for the betterment of all.

44. For development to be nurtured in the society when technology is utilized for the production of goods and services, there is need for the existence within that society of a body of competent institutions, individuals with relevant know-how and skills and with capabilities in defining development and production needs in technological terms; identifying alternative forms of technology to satisfy those needs; identifying competitive sources of procurement; negotiating ownership or user rights; or organizing importation; setting up management operations and maintenance; undertaking lateral transfer by adaptation within existing uses or to new uses; and developing new forms of technology. 13/

45. The extent to which a society is technologically dependent is demonstrated by the extent to which it fails to develop the above-mentioned capabilities, and is thus a reflection on its level of development.

46. Another aspect of the role of technology in development that should not be over-looked is that of the power that its possession and use bestows on the possessor. Those who claim to know 'how to do' and those who decide 'what to use' can, if they so desire, exercise considerable control over those who do not.

47. The implication here is the possibility that the technology selected for a particular application may be unsuitable for satisfying the needs of the majority of the population; and when thus used, economic growth in terms of increased productivity of goods and services for a few will be realized at the expense of sound socio-economic development.

13/ "Africa and the New International Economic Order: A Reassessment", National Bank of Egypt, Diamond Jubile Commemoration Lecture delivered by Adebayo Adedeji, Executive Secretary, ECA, 19 December, 1979, Cairo, Egypt.

48. It is thus clear that technology can be an agent of development (i.e., it can produce gainful employment, enhance self-confidence and self-reliance and improve quality of life), as well as a tool of social control which gives it political dimensions. Technology as a consequence can be used by the decision-makers of a society to produce goods and services for the benefit of the majority and so cause development to occur or it can be abused to satisfy the needs of a few. How it is used or abused depends on the development goals or options selected. Suffice it to say that each selection is accompanied by its attendant risks. Each country, however, is free to choose, and the issue of 'who makes the choice' accordingly looms large.

The Scope and Dimensions of Science and and Technology Policy

49. It is essential, therefore, for developing countries in general, and Africa in particular, to recognize that political will is a primary and necessary condition for promoting the concept in their societies that technology is for development, which in turn is a process of socio-economic changes for the betterment of all and not just a few.

50. A country needs to determine or make a correct identification of its desired development goals and then undertake a pragmatic analysis of the steps required to achieve them. The initiative and responsibility for taking the required steps must be internally generated.

51 This approach should involve, for example, the issuance of necessary guidelines, the establishment of legal machinery, implications of personnel requirements, new scientific work, R & D, designs, materials, machines and investment, assigned responsibilities, setting time-tables for and monitoring the execution of programmes, provision of access to markets, etc., depending on the needs as perceived.

52. The lesson is that a complete system is being planned with institutional, linkages, logistical support services, necessary infrastructural elements etc., to ensure a balanced development - a long but properly managed and well-organized process.

53. A decision, therefore, as to what scientific and technological components would go into such plan is to be made within the requirements of the country's development goals and the selected elements of science and technology depends to a large extent on its decision-makers. E.g., the choice of technology to apply to produce the goods the society would like, the services to be delivered to its citizens, the range and quality of skills to be produced from internal and external training institutions, the institutions to establish, inter-disciplinary teams required for complex operations etc. The scope and dimensions of science and technology policy should encompass such decision-making.

54. In many African countries, unfortunately, development of the kind described above has not been realized. Development strategies of over the past two decades have followed a pattern alien to the societies concerned;

decisions on choice of technology, sources of technology and negotiating strategies for the transfer of technology are often subject to the dictates of the external sources, and these have not satisfied the needs of the majority.

55. The above situation has aggravated the extent and significance of technological dependence of African economies on the whims and dictates of the industrialized economies; it will continue to exist as long as the policy-makers, planners and intellectuals in these countries fail to understand the dynamics of socio-economic change, and neglect the study of the characteristics and environment in which the people who should receive and use such technology operate.

56. It is of overriding importance for decision-makers of such societies to realize that efforts to create accelerated socio-economic change and improved living standards are principally their own responsibility. They should put a premium on the acquisition of knowledge about their socio-economic milie and lay emphasis on the selective development and upgrading of institutions, techniques, processes, procedures and attitutdes to work used by their ancestors, utilizing to the utmost extent indigenous resources to understand and subsequently cope with their environment.

The African Socio-economic Situation

57. A brief summary of the economic and social characteristics of the African economy is presented as a background against which the major issues of science and technology development in Africa can be examined.

58. Africa accounts for between one-fourth and one-fifth of the world's land surface; the population of the continent in 1975 was 410 million, with a growth rate approaching 3 per cent. At this rate it should now be 470 million (1980).

59. Of the 49 independent States, thirty have an estimated population of 5 million or less, nine a population of between 5 million and 10 million, eight a population of between 10 million and 30 million and two a population of more than 30 million. 14/

60. In terms of economic development, 22 are characterized as least developed, 28 as the most seriously affected in the economic crises of the 1970s, 14 are land-locked and 6 are island countries.

61. About 80 per cent of the people live and work in the rural areas. A sizeable portion of the work done in such areas is performed by women.

14/ For a fuller examination of picture presented in paras., see the African Economy - Background to the Examination of issues of Technology Transfer, Adaptation and Development in Africa - E/CN.14/ACTT/2/Add.1, 20 September 1977.

62. The continent possesses vast but largely underdeveloped mineral resources; it is also rich in energy resources a significant portion of which is yet to be developed. The forest resources are ample, although they are poorly managed. Its agricultural resources are also vast, but many countries are deficient in food supplies - a condition which continues to aggravate yearly.

63. Of the 42 international rivers and lakes in the continent, only few are exploited for long distance movement of goods and people; railway links are highly fragmented, while inter-state road links are underdeveloped. The transport and communication facilities within and between countries therefore need urgent attention.

64. With regard to education, housing, health and other social factors, the out-look is rather dismal with literacy rates ranging between 5 per cent and 6 per cent with 23 countries having below 20 per cent. With respect to life expectancy, the figure ranges between 38 years and 65½ with 35 countries below 45 years. 15/ Of the total work force of 140 million recorded in 1972 the unemployed and underemployed in urban and rural areas accounted for 10 million and more than 50 million respectively.15/

65. The continent is thus seen to offer a wide range of challenges for the development of technology, but the structure of most African economies prevents these challenges from being expressed as effective demands for the use of indigenous supported or adapted technology which will point the way to the production of goods and services for the betterment of all. However, the activities conducted within many of the weak African economies just described to seek solutions to their problems leaves the penetrating observer flabbergasted, to say the least. They are carried out in enclaves and semi-enclaves, between industry, agriculture and the service sectors; within agriculture, mining and industry; in education and other sectors. Facilities and staff lack, the linkages to each other and to the social environment.

66. The nature of activities of the potential users of technology such as the rural woman and her counter-part in the urban areas, local businessmen in farming, in shoe-making factories, vehicle maintenance and repairing, export and import trade, small-scale transportation, small-scale building and construction, consultancy services and middle-level management positions

---

15/ Developing countries and Levels of Development, E/CN.14/L.81, New York, 1976.

16/ "A Basic-Needs Strategy for Africa - Report I, Part I" of ILO Director-General to the Fifth African Regional Conference, Abidjan, 27 September - 6 October 1977.

and even public enterprises are seldom given any serious thought when national development plans are being prepared.

67. Because no problem is perceived in some of these cases no problem-solving procedures are intiated. There is hardly any attempt made to integrate this environment and develop local technology to satisfy the needs crying for attention. Any growth that occurs is therefore unbalanced and lopsided.

68. The markets are largely export-oriented (i.e., out of the continent) and therefore provide minimum relief for the majority of the local population. But in the developed economies, the markets are primarily their domestic market. It is when there is a surplus that external makrkets are sought. Potential intra-African collaboration in search for possible markets, current efforts notwithstanding, and, the establishment of machinery to promote production and distribution is largely non-existent but some countries do not hesitate to combine their markets with those of former metropolitan power.

69. The technical requirements of many of these African countries are thus left in the majority of cases in the hands of the transnationals. These companies diversify their activities and operate under several nomenclatures. Some of them are in fact subsidiaries of the same company. 17/ They have free reign because of the low level of scientific and technological capabilities in such countries and the encouragement received from the local enterprises which are often beneficiaries, and policy-makers who demonstrate no sensitivity for the potential social damages and often put personal interest above the national interest. Although sometimes the multinational corporations claim to offer technical assistance in the training of manpower, the skills are hardly transferred to the proper sector of the local economies largely because of the inadequate provision of safeguards in contract documents to ensure that such training is actually carried out and those trained are made to assume top-level management positions to exercise their skills within the local subsidiary.

70. It is also a well known fact that any skill that is imparted is incidental because the transnationals are primarily involved in such activities to discover cheap sources of labour, a ready supply of raw materials, access to easy markets, and quick profits, and not so much to develop local capabilities.

71. An example of the range of production activities in which they are involved will illustrate the point. Many areas are so specialized, as in the case of the extractive industries, that they have no forward,

---

17/ In West Africa, for example, the United Africa Company Limited controls Lever Brothers Ltd., Bata Shoe Company, G.B. Ollivant Ltd., and Kingsway Stores.

backward or lateral linkage possibilities and are therefore not carriers of broadly applicable technology or production skills.18/

72. They engage in coffee, palm-oil, sugar, cocoa, and rubber production; some are involved in the exploration, transport, refining and marketing of petroleum products; others are engaged in agricultural activities, mining, refining and processing of mineral ores, and energy resources. Their prospecting activities in the mining sector include cobalt, copper, diamonds, uranium, manganese, plantinum, phosphates, zinc and gold.

73. These activities are generally conducted at great cost to the countries concerned, some of which include the following: limited research and development activities by the foreign firm to discover solutions to local problems; utilization of largely foreign inputs in imported technology arrangements resulting in the non-utalization or development of available local resources; the technology utilized at times is highly capital intensive so that local opportunities of increased employment are not available; top-level managerial, engineering, financial, and marketing skills are seldom transferred as such positions are usually reserved for foreign nationals; other restrictive business practices prevent the attempt of the local subsidiary to search for and procure alternative sources or even new forms of technology; in addition efforts to unpackage imported technology into its component parts and accessories by the subsidiary are prohibited; the transnational further competes successfully for the procurement of funds for its activities in the local financial markets thus preventing access of indigenous firms to development finance; huge fees and payments are extracted from the local governments for imported technology.19/

74. African countries therefore ought to collectively devise ways and means to better negotiate the transfer of technology by the transnationals after a careful study of the conditions under which such firms operate.

75. The kind of "technology-free" transfer which occurs in some African countries by the way of assembly and turn-key plants which depend on massive foreign inputs for their components, raw-materials, spares and even for their management - the foreign consultant or foreign partner - should be discouraged by all countries.

76. "The largest machine in the world is made up of parts and accessories. The kinds of knowledge, skills and experience gained by assembling motor

---

18/ This, of course, assumes that processing and other activities which require technical inputs are conducted overseas... the case of alluvial diamond mining is cited.

19/ For a fuller treatment, see Report of the Intergovernmental Group of Experts on a code of Conduct for the Transfer of Technology, UNCTAD, TD/B/C.6/ 14. 1976.

vehicles have very little to do with the kinds of knowledge, experience and skills required to manufacture any one of its parts. This applies equally to mixing paints, chemicals and pharmaceuticals or, worse still, to packaging or bottling and the like. Yet activities of this kind constitute a large part of what passes for industrial development in Africa. The growth of such activities "simply means an accumulation of negative-value added". Since there is no significant structural relation within this 'sector' or between it and other sectors such as agriculture, it has little propulsive effect and many of the industries are actually semi-enclaves. 20/

77. Technological co-operation in industrial development should be fruitfully explored if African governments demonstrate some interest. In fact, 53 technological projects were found in a recent survey to be feasible for execution on a collective self-reliant basis, if the necessary skills and infrastructure were available. The survey demonstrated that projects in the following areas could have been successfully implemented by the following countries as indicated; sugar involving Ethiopia, Somalia and Kenya; ceramics involving Ivory Coast, Togo and Ghana; aluminium ingotinvolving East Africa; pulp and paper mill involving Guinea, Sierra Leone, Liberia, Mali, Congo, Gabon, Chad, Zaire, and Cameroon; glass involving Kenya, Zambia, Somalia, Ghana, Upper Volta and Ivory Coast, etc. 21/

R & D Institutions, Other Institutions and Manpower

78. In respect of R & D, some amount of research facilities exist including even a few items of sophisticated equipment and some scientific research is conducted on a regular basis in universities and research institutions in the countries of the region. There is however, a real need to examine the situation in two directions, namely the relevance of the research to the real needs of the economy and the reorientation of the R & D into an R, D and E operation. The E - here lays stress on the engineering and production aspects of the work and covers such areas of competence as engineering design, production engineering, industrial design and pilot plant operations which are some of the critical areas of shortage in the technology-for-production situation in Africa.

20/ See, Industrial Development Processes and Industrial Development Policy Note by ECA Policy and Programme Co-ordination Office, 1970 1970-1989 b/ PPCO-330.

21/ See, Specialization, Complementarity, and multinational Industrialization in Africa, ECA, E/CN.14/638, 1975.

79. The research activities engaged in, often bear little direct relationship to the development needs of the countries of the region. The research results from such institutions therefore represent isolated pieces of information or pure science solutions to disparate problems. Although some of these results can, with suitable adaptations be utilized in applications designed to solve the countries' problems, this is unfortunately not done because of the absence of adequate and effective linkages between the knowledge generating and the productive and commercial activities - between the innovative systems and the productive systems.

80. Because of the size of the economies, limited resources, the nature and range of problems to the solved, institutions must be established and existing ones restructured and reoriented not only at the national level but also at the subregional and regional levels. The assistance of other Third World Countries especially those in Latin America and Asia not forgetting the late developers - Japan and China - should be sought for the provision of techniques, procedures, and structures.

81. With respect to the development of scientific and technological capability, a study by UNCTAD discloses the following: in terms of technicians engaged in research and development activities per 10,000 population, Africa had an average of 0.4 as compared to 1.4 and 8.2 in Latin America and developed countries; in terms of technicians per 10,000 population, the figures for Latin America and developed countries were 22.2 and 142.3 as compared to 5.8 in Africa; the corresponding figures for scientists and engineers per 10,000 population were 69 for Latin America 112 for developed countries and 5.8 for Africa but for the same cadre of people engaged in research and development activities, the figures were 0.38 for Africa, 1.15 for Latin America and 10.4 for developed countries. The ratio of primary and secondary enrolment in schools to the school age population was discovered to be 78 per cent for Latin America, 92 per cent for developed countries and 32 per cent in Africa. 22/

82. A better reading of the above situation can be obtained from a survey in quest of determining the level of scientific and technological capabilities of some developing countries. 23/ The survey revealed that the African countries visited lacked capabilities in and adequate mechanisms for identifying their technological needs, searching for alternative technology. evaluating and selecting appropriate technology, adaptation

---

22/ Transfer of Technology, TD 190, UNCTAD 1975.

23/ UNCTAD - Terminal Report of Exploratory Mission - Geneva 1975. The following African countries were surveyed: Botswana, Burundi, Ethiopia, Lesotho, Niger, Senegal, Sudan, Uganda, Tanzania, Upper Volta, and Zambia.

and diffusion of transferred technology and developing and diffusing local technology

83. A somewhat similar study 24/ of some developing countries conducted for the Commonwealth Secretariat discovered weaknesses and inadequacies in the following areas: related data and information facilities, entrepreneurial, managerial, supervisory and operative skills, infrastructural facilities (training and R & D), for example identification of potential industries and technological investigation and negotiation expertise.

84. The African region is richly endowed with natural resources. It possesses abundant supplies of agricultural, forestry, mineral and energy resources. However, due in large measure to the lack of technological capabilities, African countries present a picture in terms of development, of scarcity in the midst of plenty. Although some technological capabilities exist for the exploration of natural resources in the form of identification of resources capability and study of resources characteristics, there are weaknesses in capability for the study of the industrial and development potential of local resources, and a lack of indigenous technological capability for the exploitation of local resources in the best interest of national socio-economic development.

85. The lack of scientific and technological manpower in African societies in unfortunately largely due to the ignorance and "colonial mentality" of African policy-makers and others who constitute small but influential groups of the populations of these countries. They systematically downgrade indigenous life-styles and development patterns in favour of those copied from industrialized countries.

86. One manifestation of this syndrome is the arrogant refusal of youth to 'dirty' their hands. Preference is usually given to white collar jobs, which have a minimal impact on the development process.

87. There is hardly any appreciation of the degree of human dignity which derives from labour on technical and other kinds of highly productive work, nor of the degree of competence, confidence and self-reliance such work imparts to the worker.

88. Due attention, therefore, ought to be given to the content of education programmes most of which are currently patterned after those prevalent long ago in former metropolitant countries. With regard to the development of technical entrepreneurship there is need to direct attention to current practices in the training of technical manpower. At advanced levels, training programmes need to be reoriented towards the production of

---

24/ Technology Transfer and Development by Pers India Pvt. Ltd., prepared for the Commonwealth Secretariat, London, 1978. The following African countries were visited: Kenya, Nigeria, Sierra Leone, Tanzania and Zambia.

technologists and not merely engineers with the traditional 'conventional' disciplines. This would require the introduction of courses in economics, management, technology (e.g., history of technology development, the impact of technology on society, technology generation and diffusion), and law.

89. There is need also for the students, especially those in design, to familiarize themselves with many other fields and by knowing them redefine the relevance of the designer to our society. The insights of the social sciences, biology, anthropology, politics, engineering and technology, the behavioural sciences and much else must be brought to bear on the desing process.... But the most important ability that a designer can bring to his work is the ability to recognize, isolate, define and solve problems. 25/

90. In other words, the learning by doing method and skill transfer and the 'demonstration effect' in a production type situation must be given top priority to produce the professional with the versatility required to solve design problems in the country.

91. At the middle level where the need is currently acute, measures must be taken to introduce elements of the above programme in middle-level education programmes, adequate attention being paid to student motivation. Empahsis must be placed on 'trouble shooting' techniques.

92. Education at the primary level, should aim at providing instructional materials, highlighting the role of technology in society in a simple and demonstrative manner. At this stage, an understanding of the rural environment and the use of traditional technology by past and present African rural societies to relieve their burdens should form major components of instruction, inter alia, at this level. Here, again the "learning by doing" method of skill and knowledge transfer should play a significant role.

93. Furthermore, co-operation arrangements will have to be effected at the subregional and regional level to assist those countries of the continent with meagre resources to benefit from this proposal.

Technology Assessment and the Role of Technological Information

94. There are two factors which govern the role of technology assessment in many African countries, namely the life-style of the dominant socio-political group and the level of ignorance from which they operate. These factors, in turn, invariably affect the choice and ability to adapt imported technology.

25/ Design for the real world - Victor Papanek, Paladin Books, 1974, pages 131;132.

95. Many a criticism has been levelled by against multinational corporations for transferring to African countries, technology that propagates Western tastes and products which cannot be adapted to local conditions However, part of the blame for this situation must also be laid on the dominant socio-political group in many such societies, who are invariably clustered in urban areas and usually practice life-styles and patterns of living which are immitations of the behavioural modes and development predispositions of people living in advanced economies.

96. This group determines for the ordinary citizens, the type of society they want to create and which life-styles they aspire to, and in consequence what actions and technologies would be most suitable to achieve these goals. However, because of their ignorance of the peculiarities of the local socio-cultural milieu, and lack of informed access to the technology market, unsuitable technology is transferred without knowledge of other sources which might be cheaper insspite of the inadequacy of the selection. The society therefore, in terms of cost, loses twice - high cost technology is transfrerred, unassessed to serve the needs of a few.

97. This fact raises the important issue of scientific and technological information. Technology is sold on the world market in the form of machines and equipment, know-how or blue prints, patents and licenses, or it shows up as free technology which is the sum total of technical expertise that man has built up over the centuries, the use of which involves no entitlement to royalties or remuneration of any kind.

98. Without effective scientific and technological information services at the national and regional levels to cater principally to users, there can be no informed access to markets; the buyer will be influenced by extraneous factors in his choice of technology (tied aid etc.,) on the one hand, and can be duped on the other hand by purchasing technology in the form of patents which, having entered the public domain are free. This situation which results from the buyer's lack of information, perpetuates his technological dependence.

99. Another aspect of the same 'coin' is the fact that the chances for innovation by purchasers of whole industrial complexes or their sub-units are minimal or non-existent. Adaptation therefore becomes impossible without scientific and technical information services which might have enabled the buyer to unpackage the technology complex diversify his potential sources of supply and combine various technological elements in an innovative manner. The possible transference of skills through assimilation is thus prevented.

100. However, the presence of adequate scientific and technological services at the national and regional levels does not automatically and per se guarantee the choice of suitable technology or the adaptation of imported technology for productive uses within the African economies. There must exist in such societies policy-makers who are conscious of the needs of the majority and willing to satisfy them. The absence of

such people will only perpetuate technological dependence. Political will and commitment to restructuring such economies constitute a primary condition for progress.

101. An understanding of the reasons for the technological backwardness of the continent, and the instituting of corrective measures to transform it, are necessary conditions for the creation of a new national and regional economic order for African countries.

102. The extent to which the negotiations on the international scene are successful depends on the extent to which such restructuring is undertaken in African national economies. The salvation of the continent therefore lies in the hands of its policy-makers.

PART II

PROGRAMME OF ACTION FOR AFRICA

Guideline for a Programme of Action for Africa

103. There are certain factors which must be taken into account in planning the socio-economic development of a country, recognizing technology as an inevitable tool for such development. Several of these factors relevant in the African scene are presented below as guidelines-for-the evolution of a programme of action for the effective utilization of science and technology for development. They are presented with the full knowledge that there is no single prescriptive path to development. Each African country has to make its own choice of a path; but it is hoped that every country will use most, if not all, of the elements proposed below not only on its own but also in co-operation with other countries: in view of the small size of markets and other handicaps of many countries in the region, co-operative action enhances prospects of achieving desired goals.

Political will and commitment

104. It is essential, within the African context, for Governments to realize that for uniform economic and social development to occur in their societies, utilizing the tools of science and technology, significant structural transformations must be initiated and maintained. National development policy should aim at an integrated development of all sectors of the economy in well-defined stages with established performance indicators 26/ which would be monitored to ensure that a better 'quality of life' will result for all citizens.

105. A 'better quality of life' in this context can be interpreted to mean that Governments should display a more sincere concern than ever before over the urgent need for, inter alia, a better distribution of income; gainful employment (and not underemployment) for the employable; better education, housing and health care; enhancement of culture; upgrading of skills and for manufacturing a range of products purchasable by low-income groups as well as by the more affluent among their societies. A systematic utilization of science and technology would be required to achieve these ends.

106 Emphasis should also be placed on creating mechanisms for saving foreign exchange by concentrating on domestic markets and on earning foreign exchange by encouraging activities which increase the sales of exports (e.g., emphasis on the development of the domestic market for food while encouraging R & D to increase the yield on both food and export crops) primarily in markets created by groups of nations within the continent followed by markets of other third world countries and then the rest of the world market. The capital accumulated in this way could be fruitfully utilized in the strengthening of indigenous scientific and technological capabilities.

26/ This means that a national development plan, instead of only setting targets to be attained in various sectors of the economy, would also consider possible paths to achieve them. This way the progress of implementation could be easily measured. It also means that a 'map' should, at first, be conceptualized of different sectoral priorities and the links between them. Then an overall strategy should be devised for its consistent development.

107. African Governments should also carefully examine the prevailing conditions under which technical assistance and other agreements are contracted and under which technology is transferred. It is absolutely essential that these should be supplied untied and under conditions favourable to recipient governments.27/ Attention should be paid to the impact of such activities not only on the total environment but also on development goals.

108. A conscious effort should be made by African governments to create an environment in which science and technology can thrive by popularizing such activities, i.e., by awards for spectacular achievements, by demonstration of new techniques etc. A special premium should be placed on efforts aimed at bringing about the enhancement of traditional life-styles and customs. Since 80 per cent of the continent's peoples live in rural areas, due attention should be paid to measures that improve the conditions of the rural populations and eliminate the suffering caused in these areas because of the pattern of activities in the urban sectors. This means that the nature of the current linkage between the rural and the urban sectors in which the urban sector controls the overall economy of the community must be examined and modified. Every encouragement must indeed be given to the generation and diffusion of technologies for satisfying basic rural needs.

109. African Governments should also not hesitate to make full use of the organs, organizations and bodies of the United Nations system, especially the Regional Commission for Africa, in their efforts to chart a development path acceptable to and adequate for the majority of their peoples. Three specific responsibilities of the Commission are of particular relevance in matters of science and technology development:

"The Commission ... shall ...

"(b) Make or sponsor such investigations and studies of economic and technological problems and developments within the territories of Africa as the Commission deems appropriate, and disseminate the results of such investigations and studies;

.....

"(f) Assist in the formulation and development of co-ordinated policies as a basis for practical action in promoting economic and technological development in the region;

"(g) In carrying out the above functions, deal as appropriate with the social aspects of economic development and the interrelationship of economic and social factors". 28/

27/ The acquisition, control and utilization of increased amounts of industrial technology, the development of scientific and technological human resources to perform a wide range of adaptive engineering and adaptation of technology from foreign sources to suit local needs of the majority should be of primary concern here.

28/ The Terms of Reference of the Commission: See Economic and Social Council resolution 671 (XXV); see also document E/5453, page 19.

110. "The ECA has been assigned by the Economic and Social Council the responsibility for providing, in the African region, the framework for the orientation and co-ordination of the activities of the United Nations system in the application of science and technology to development. To respond to this role and to carry out this task, a Science and Technology Unit has been established within ECA. The major functions of this Unit include: (i) to serve as the focal point for regional activities; to promote co-operation among member bodies; (ii) to ensure that programmes for science and technology reflect genuine African needs and priorities; (iii) to consult with, and assist governments and institutions on the most effective and economic means of promoting science and technology; and (iv) to secure the interest and support of institutions providing aid for programmes in science and technology at the national and multinational level.

111. The institutional framework of the Economic Commission for Africa is supplemented by the regional structures established and the regional operations conducted by several other organizations of the United Nations system. A system-wide network of concerted activities is thus geared to the over-all goal of turning science and technology into an increasingly effective tool for the socio-economic development of the countries of the African region".29/

112. But, 'Science and Technology' cannot thrive in a vacuum. They are part of the socio-cultural milieu in which they are to be developed as was illustrated in the earlier sections above. Their adequate utilization for development must be preceded by or run in parallel with efforts to create the right environment in which they can be utilized successfully. Such an environment will only come about if African policy-makers take pragmatic steps to restructure the current form of their national economies along the lines already suggested. Political will and commitment within this context is a must. Some required actions in the field of science and technology are enumerated below.

PROGRAMME OF ACTION

Science and Technology Policy

113. Each African country must define its set objectives to be realized through the use of science and technology; these objectives will determine the extent to which science and technology will be utilized, when, where, and how effectively.

114. Science and technology resources should be used for raising African standards of living, relieving misery in the rural areas and urban slums etc., and drastically reducing the technological dependence of the continent.

115. A science and technology plan should indicate long-term and short-term scientific and technological development within the framework of a national development plan. It should contain proposals for action, stipulate when the actions would occur and mechanisms for their implementation.

29/ Description of the role of the United Nations agencies in the application of science and technology to development in Africa: A paper submitted for consideration by the African Regional Meeting on UNCSTD.

Development of human resources

116. The development of human resources for the creation of a science and technology infrastructure of manpower, knowledge, skills, innovative and productive capacities to absorb and adapt imported technology on the one hand and on the other to locally develop technology for the identification, exploration and exploitation of natural resources and the conversion of raw materials into semi-finished and finished goods and products; this would entail a drastic change in the orientation of education and training programme within a newly created social infrastructure in which education facilities and health services are accessible to all and the dignity of mechanical work accorded a high social value.

117. Urgent attention should be given to the development and encouragement of technical enterpreneurship. This requires the introduction of technical training into the education system at an early stage, and the introduction of basic management courses in existing conventional engineering curricula.

Development of technology (R & D)

118. Special attention should be paid to the socio-cultural millieu of the majority of the population and an attempt made to satisfy their needs by upgrading traditional technologies, developing new ones and adapting imported technology. The roles of invention, innovation and diffusion should be given top priority in this context. It is necessary to have existing scientific and technological capability, a market demand, and some mechanism to transform capability into goods and services to satisfy the demand.

119. The Government should undertake a study of the technology development and diffusion mechanisms while at the same time encouraging the balanced development of rural industry and agriculture so as to ensure that there will be a need for rural goods and services as well as for the technologies to produce them.

120. The development of R & D should be encouraged in this exercise by the creation of a competitive environment with the research undertaken at the universities and other institutions geared towards development needs. When relevant inventions occur, technical enterpreneurs can transform these into concrete elements of production, thus providing a much needed linkage between the innovative system and the productive system.

Transfer of Technology

121. Action should be taken to ensure that technology is transferred under general conditions decided internally which will enable the recipient country to pursue a self-reliant, self-sustaining strategy in the development of local scientific and technological capabilities. Satisfying the needs of the majority should be a major goal or criterion for such transfers. Technical Assistance and foreign aid programmes should be carefully scruitinized by established machinery to ensure that the country benefits maximally from these programmes and that balanced socio-economic development could result.

122. Such machinery should regulate the technological and other activities of transnational corporations in the recipient country in areas such as the development of indigenous scientific and technological skills; the generation of local employment opportunities; the transfer of technological and managerial knowledge to local distributors and users of capital goods and other products manufactured by the local subsidiaries. The end product of skills and locally managed manufacturing enterprises - the fixation of technological and managerial talents in the recipient country - should come about as a result of writing-in time constrains, monitoring procedures, skill transfer nature etc., into 'TNC subsidiary - recipient country' contracts.

Technological Information

123. Lack of information is one of the most serious obstacles to the selection, acquisition and use of appropriate technology options.

124. The local environment plays a very important role here. An understanding of the character and orientation of the transferees is as important as the information to be supplied. Care should be exercised to ensure that the supply matches the demand.

125. Machinery should be established to assess and promote the acquisition and dissemination of information on the range of alternative technologies, processes and products available for a particular application.

126. This approach is essential for the promotion of R & D and the enhancement of innovation, the issuance of patents for such work, for up-grading skills, techniques for easing drudgery, for having consultation and exchange of information with other African and Third World countries in areas such as the dynamics of Science and Technology policy and planning, for the building of Science and Technology infrastructure etc.

Institution Building

127. Institutions and/or institutional arrangements are required for the development of technology, the regulation of transfer and adaptation of technology, for educating and training scientific, technological, managerial, marketing, and financial manpower at various levels, and for financing development activities.

128. This is an area to which the plan must give due consideration; considerable political will and commitment on the part of policy-makers is required to create adequate institutions restructure and reorient existing ones to enable them to provide effective solutions to the problems of development.

129. Critical areas for which such institutions should have capabilities to include such as transferof technology, in particular, in respect of the mix between locally generated and imported technology, assessment and selection of technology including unpackaging and evaluation of components, and mechanisms for adaptation to local conditions. Institutional arrangements are needed on a continuing basis to provide the inter-disciplinary teams required for these complex operation.

130. Institution building for the effective utilization of science and technology in development should therefore embrace the whole spectrum of policy-makers, development planners, development agencies, technology users, scientists and technologists.

Linkages

131. This is an area which should be given high priority in the plan because of its importance in the national effort to bring about socio-economic development.

132. The national R, D & E effort is geared to the achievement of national goals. Therefore the Science and Technology plan should ensure that effective linkages are created between and among various sectors of the economy including government, industry, and the education/research establishments.

133. Machinery should be available for scrutinizing all technical assistance and aid projects and those to be financed from local resources to ensure that no unbalanced growth will occur. Everything must fit into the nation's planned stages of development of the conceptualized 'map' for national socio-economic development.

134. Any project that cannot fit into this structure should be rejected and replaced with a suitable one.

Finance

135. The generation of finance for Science and Technology activities is another area which should be given due attention in the Science and Technology plan. A broad guideline for operation is to ensure that once the resources are raised, the decision as to how they should be utilized should rest with the local government.

136. Current patterns indicate that external lending agencies stipulate terms under which financial resources are released for project execution. The country should ensure, if capable local personnel are available that they assume the lead technical and managerial positions. If this is not possible, then the foreign team should be required to train local personnel in these areas.

137. Producing primarily for the domestic markets should be encouraged to save foreign exchange. Activities which increase the sales of exports to earn foreign exchange should also be given due attention.

138. Possibilities for collaboration between local and foreign governments on Science and Technology projects should be explored under conditions favourable to the local government. Such conditions should be inserted into agreement e.g., products from such projects can be useful to pay for projects equipment etc. Technical training can be obtained either for a minimum fee or free of charge; payment of royalties can be avoided in exchange.

139. Possibilities should be explored for establishing a financial institution for Third World countries from their own resources for the financing of sub-regional, regional and interregional Science and Technology development projects. This institution could also channel funds from external aid sources to ensure that the decisions as to their use are made with due respect to the concepts of autnomy and self-reliance.

140. Provision should be made for increased African representation at decision-making level in the newly established Financing System for Science and Technology for Development, as well as in existing international funding agencies.

Markets

141. The plan should take into consideration the small size of markets in individual African countries, and explore possibilities for developing viable mechanisms for the promotion of markets other than the domestic ones within the continent for manufactured capital and consummer goods and services.

142. Provision should be made for collectively exploiting markets in Third World and Developed Countries in that order.

143. Adequate arrangements should be made for establishing national and regional standards institutions and strengthening existing ones, as these are vital for technological and industrial development.

Co-operation

144. Each country should take adequate steps to foster links, bilateral and/or multilateral with African or Third World countries as a conscious effort to promote collective self-reliance. Political support for such co-operative efforts should be readily available on a continuing basis.

145. The possibilities for such co-operation in the development of projects and the setting up of subregional, regional and interregional institutions should be fully explored. Programmes of technical co-operation among developing countries should be given high priority, since these are effective means of eliminating technological dependence.

146. The provision of aid for development given on a multilateral basis to countries of the region should be encouraged to ensure that the full economic impact is spread over a wider area.

147. Arrangements should be made for seeking assistance from United Nations organs, organizations and bodies, in the country's effort to develop indigenous scientific and technological capabilities.

148. Passing reference should be made to the important realm of "technology forecasting" which should be an area of concern and for co-operation between African and Third World countries and the industrialized world. There are major scientific and technological developments currently in progress in the developed world, such as the impending micro-processor revolution, of which the majority of Africans are ignorant and which unfortunately had not been assessed for their impact on the future development of African countries. The implications of this sad state of affairs for African countries have many ramifications.

149. For example, microprocessors are the most exciting use of micro-chips. Africa cannot afford to overlook the assessment of the impact of this micro-miniature technology on her societies. Ways must be discovered to fully exploit this new technology. The developments in this area and some others should be fully understood through education and discussed so that either appropriate R, D and E work can be carried out on them to improve the quality of life in such societies or certain measures taken to prevent future disasters if these are forecast.

150. Computing and telecommunications are now rapidly merging. There is no reason, for example, why computer asissted instruction cannot be utilized to eliminate illiteracy in many African societies. A concerted effort should, therefore, be made to provide machinery at the national, regional and international levels, to co-ordinate, provide consultancy services and training (within the context of an early warning system) and assess the impact of the electronic, the laser, the genetic engineering revolutions, inter alia, on the future development of African societies.

151. Other regional and international organizations with adequate competence should be fully utilized when advice and other forms of assistance are required. Maximum political and financial support should be given continuously to African regional organizations such as the African Regional Centre for Technology (ARCT), the African Regional Centre for Engineering Design and Manufacturing (ARCEDM), the African Institute for Higher Technical Training and Research, Industrial Property Organization for English-Speaking Africa (ESARIPO) and French-Speaking Africa (OAPI), and Pan-African Documentation and Information System (PADIS) to enable them to execute their mandates of providing assistance to member States.

152. The Organizational Unit within the United Nations Economic Commission for Africa mandated to co-ordinate science and technology activities in Africa should be restructured to make it more effective in executing its tasks, through the provision of adequate resources. In this connexion attention is invited to the resolution adopted by the African Regional Meeting for UNCSTD held in Cairo, Egypt in August 1978.

MACHINERY FOR IMPLEMENTATION

153. It is thus evident that the African region has continued to be technologically backward and dependent on industrialized countries principally because many African countries have failed to take most of the required actions described above, that are necessary to bring about self-reliance.

154. The governments of the countries of the region have to realize the urgent need to break with the past, inter alia, for two grave consequences:

> "The first is that many of the technical components of production, transportation, marketing (skilled manpower, technology, capital goods and services, finance, physical and institutional infrastructure) were supplied from abroad and most of them penetrated the economy and society through very narrow channels. Little attempt was made to promote their spread into other sectors and sub-sectors and the economies became characterized by enclaves, semienclaves and dysfunctional relations so that attempt to promote overall changes in pace and direction of the economy and society as a whole by conventional methods based on conventional concepts largely failed. This situation persists today, and it is not often realized, how extensive and paralyzing the presence of these enclaves is, semi-enclaves and dysfunctional relations -- in agriculture, industry, in transport, in education and human resources development, in technology, in the structure and functions of governments, in the exploration, evaluation and use of natural resources, in the spatial organization of socio-economic activity, in market structures and dynamics.

"The second consequence, closely linked to the first, was the establishment of a pattern of dependency of Africa on advanced countries which, with every effort to diversify anda accelerate economic growth, particularly when this effort reflected attempts to develop on the lines of the models that were generally familiar, was extended to new areas of socio-economic activity and became more consolidated, so much so that today we depend on advanced countries for the supply of services of skilled personnel and institutions so extensive in scope that are trivial and many that, with a little effort and imagination, we can acquire, develop and use ourselves. We depend on them for technology, for capital goods (including the production and supply of simple implements and tools, parts components and accessories), for development finance; for transportation and marketing not only in the advanced countries themselves but even in other countries and within the region. We depend on them for natural resources supply in the sense that few countries in the region can explore, evaluate and extract their own mineral resources for their own use or for export to other African countries without the intervention of agencies and services from advanced industrial countries. We depend on them for the demand and supply forces determining the direction and pace of economic growth and, in some cases, for inspiration on desirable patterns of development and life-styles." 30/

155. The questions that need to be asked are:
What type of development process should Africa initiate in the 1980's?

What methods should be devised to do bring it about?

The political will and commitment mustered by African governments to take the necessary actions and to establish the kinds of machinery necessary will determine the fate of the continent.

156. The machineries available for the implementation of the needed actions set out in the previously mentioned science and technology plan are presented below. It is to be noted, however, that they are by no means exhaustive. There are also some overlaps. The listing is purely indicative; each country can add to this indicative list as it sees fit, but substractions and deletions are to be discouraged if effective strengthening of national scientific and technological capabilities is to result.

DEVELOPMENT OF HUMAN RESOURCES

157. At the National Level

(i) The conduct of a survey of scientific and technological manpower to determine the needs in all sectors, and the mix of professional manpower requirements on which development should be based.

30/ Africa and the International Development Strategy for the United Nations Third Development Decade, Statement by the ECA Executive Secretary to the Second Substantive Session of the Preparatory Committee of the General Assembly for the International Development Strategy, 20 June 1979, United Nations Headquarters, New York.

(ii) Whole scale curriculum revision campaigns should be mounted by governments to cover all levels of the education system with the aim of making scientific and technological education and training more relevant to the development needs of the local African environment. This is a primary activity to be given top priority. Governments should carefully define the objectives of such revision by highlighting the need to put premium on traditional cultural values, and on an understanding of the workings of the rural society. The curriculum revisers must aim, when their suggestions are appropriated, executed, at arriving at human end-products with skills and knowledge which would make them socially useful, employable by themselves or other agents and capable of living and working in harmony with their environment. This activity should be completed in the next two years as a first phase, but with provisions for repetition as the socio-economic milieu changes.

(iii) The "learning by doing" method and "demonstration effect" should be emphasized and maintained at all levels of the formal education system by legislation. This method of skill fixation should form the basis of instruction for the non-formal programmes. New communication skills should be introduced by sharing experiences with other Third World countries. Studies should be conducted on how to use education technologies for converting the primary out-of-school/drop-out population into efficient operatives in industry, farming, and services including maintenance of equipment and structures. this is a long-term process which should be pursued on a continuous basis.

(iv) A systematic programme for the development of women for science and technology careers at all levels of the education system should be planned and implemented as of priority.

(v) Adult skill and literacy campaigns in science and technology should be mounted through the use of national languages, where possible, with the primary object of getting the rural women into agricultural and rural technology programmes and projects (e.g., food production, preservation, storage and use, nutrition, etc.), again the method of learning by doing should be utilized in this campaigns.

(vi) Enacting national legislation to ensure that TNC subsidiaries transfer skills which have backward, forward and lateral linkages (See Legal Machinery under Transfer of Technology) with the rest of the economy.

(vii) Public training institutions should be set up in priority sectors, particularly the natural resources sectors of the economy, in which the industrial environment is real, and transfer of skills

takes place on the job. The whole range of activities covering identification, exploration, exploitation, extraction, R & D, management, production, financing and marketing is to be provided for. Arrangements may be contracted with the ECA, United Nations agencies, international organizations and foreign firms, etc., to assist in training project design, planning, installation and management personnel;

(viii) Institutions should be established or strengthened for the training of science and technology teachers, instructors, craftsmen and technicians. This should be a continuous activity;

(ix) A possible range of institutions to be established is to be found in Technological Dependence: Technological Capability and Institutions Building in Africa.31/ A decision has to be made about the number to establish at the national level when the limited resources and weak economies of member States are taken into account. Participation in the activities of a regional institution or institutions of similar nature cannot be ruled out under the circumstances;

(x) Introducing a wage structure which recognizes the value of the scientists and technologists and provides satisfying material rewards for them. This should be examined immediately by all countries;

(xi) National investment in science and technology education and training should be of the order of 30 per cent of the allocation to education from the national budget;

(xii) A systematic programme of production of technical enterpreneurs should be introduced and vigorously pursued. Some of the elements in such a programme are the introduction of technical subjects at an early stage in the education system, and also the introduction of management courses in existing conventional engineering training. The "learning by doing" process is particularly pertinent in this;

(xiii) A programme should be developed to make use of the vast amount of "adaptive" and "improvizational" technology available in the form of village blacksmith shops and wayside mechanics in the "learning by doing" processes.

31/ Op. cit.

158. At the Regional Level

ECA and other regional organizations (e.g., the African Regional Centre for Technology, African Institute for Higher Technical Training and Research, African Regional Centre for Engineering Design and Manufacturing, African Regional Organization for Standardization, African Regional Industrial Property and Patent Documentation Centres, etc.), should assist African States on request in the execution of the following activities:

(i) Revising curricula at the levels of education and training to make them more relevant to development needs, and organizing training programmes;

(ii) Feasibility studies on the possibility of establishing multinational companies in various sectors whose prime purpose will be to transfer skills and knowledge on the job - these are to operate as teaching hospitals currently do;

(iii) Establishing adequately linked national and other regional/multinational institutions where justified for the development of scientific and technological capabilities;

(iv) Encouragement of the mobility of experts, students, exchange of experiences within the region and with other Third World countries;

(v) Raising funds from various sources including the United Nations Financing System for Science and Technology for Development to finance relevant science and technology activities;

(vi) Studies on how to use education technologies for converting the primary out-of-school/drop-out population into efficient operative in industry, farming and services including maintenance of equipment and structures;

(vii) Mounting training courses in science and technology policy and planning technology assessment, and techniques of negotiation and bargaining.

159. At the International Level

A. Transnational Corporations (TNCs)

TNCs wishing to co-operate with African States in establishing training programmes consistent with the African self-reliant strategy and the promotion of balanced socio-economic growth should operate under the following conditions:

Set-up agreed technical training programmes to increase scientific, technological and managerial skills with avenues for monitoring and evaluating the performance of local personnel at:

(i) Local subsidiaries and distributing agencies for their products;

(ii) Local higher technical universities and research institutes;

(iii) Parent firms and external R & D centres.

B. Developed Countries

(i) Before training exchange or fellowship programmes are planned for personnel from African countries, the governments offering such programmes should ensure that they fit in with the needs of such countries. Technical assistance programmes should do likewise;

(ii) The activities on a co-operative S and T project should be conducted in the African countries concerned to give opportunity to the indigenous or local institutions to participate. If such projects could only be undertaken externally, then African scientists and technologists should participate;

(iii) Foreign teams of experts should be led by indigenous personnel if such are available, and if not, training should be given by such teams to indigenous senior technical and managerial personnel, in the initial phases of such projects.

C. United Nations Agencies and International Organizations

(i) The possibility of giving collective assistance in line with national plans and priorities should be explored prior to entering co-operation arrangements with individual countries;

(ii) In the interest of proper execution of and maximum impact on African development programmes, inputs of various organizations should be co-ordinated through cross organizational planning in the various sectors;

(iii) The following areas warrant attention:

(a) training programmes should be conducted within the African countries if possible; if not, regional institutions should be approached; if facilities are still not available then external relevant training can be offered;

(b) The points made under B(ii) and B(iii) above are also pertinent here. In addition, explicit measures should be undertaken to ensure that during the pre-feasibility and feasibility stages and beyond of some country projects, local and indigenous consulting firms could be utilized. Where such firms are inadequate experience, they can collaborate with foreign firms which should be obligated to give such training as is necessary under closely monitored conditions to ensure that skills are being transferred;

(c) Assistance should be given to evaluate and combat the brain-drain problems;

(d) Establishment of special international fellowships in Science and Technology for Development using the newly created United Nations Financing System for Science and Technology for Development.

D. Third World Countries

(i) Arrangements for technical co-operation for development programmes and projects in the training and exchange of 'science and technology' personnel should be made;

(ii) Special attention should be given to the primary school drop-out problem - [see (iii) under "the national level"];

(iii) Priority should be given to assisting individual African nations and the African region to set up, if possible, in the principal sectors of production priorities, factories which lay stress on the 'learning by doing' method in an industrial environment - the teaching company.

DEVELOPMENT AND TRANSFER OF TECHNOLOGY

160. At the National Level

(i) A primary activity is to conduct studies:

(a) to identify the needs of the majority of the population;

(b) to understand the character of the local transferees, their orientation and preferences;

(c) to understand how technology affects development, develops and is diffused in society, technology adaptation techniques, etc.;

(d) to fully comprehend how transnational corporations operate, their structure and policies, and how these affect the development process so as to increase the awareness and perception of policy makers on all the above through seminars and workshops.

Assistance with (b), (c) and (d), can be sought from ECA, United Nations agencies and other international organizations.

(ii) National policies should then be formulated and laws enacted to guide the development and use of local technology, and to regulate the choice, flow, adaptation and use of imported technology and the activities of transnational corporations. In this also, assistance can be sought from ECA, United Nations agencies, regional organizations and international organizations;

(iii) Establishment of national sectoral centres to advise on the development, choice, transfer and adaptation of technology, and to supervise and follow-up on the implementation of technology related activities. The results of the manpower survey will assist in determining the professional skill mix in these sectors, from which adequate training programmes will be mounted to develop negotiating capacities and strengthening of bargaining positions, capacity to assess, unpackage, install, operate and maintain technology. Assistance can be sought from the African regional institutions in the field of technology, as well as from other Third World countries;

(iv) Establishment of awards and patent incentives for inventions and innovations on works done in local scientific and technological institutions, other types of institutions in industry, etc., directed towards satisfying the development needs of the rural population and to other neglected areas of development;

(v) Encouragement of the local scientific and technological personnel to participate in debates on development issues, and on science and technology matters; permitting a wide-spread display of technological achievements;

(vi) Setting-up of registers of imported technologies classified by sectors and by short, medium and long-term replacement potential;

(vii) Encouraging the establishment, as a modal point for further indistrial development, of small scale industries and artisan enterprises in the rural areas with a vigorous promotion of R & D capabilities in agriculture and small-scale industrial activity ensuring that adequate links exist between the governmental, financial and productive sectors;

(viii) Strengthening national negotiating and bargaining capabilities by crash programmes developed with the assistance of Third World countries, regional organizations, (ECA, United Nations and other international organizations)in the areas such as the following:

(a) the international code of conduct on the transfer of technology;

(b) the international code of conduct relating to TNCs;

(c) the revision of the Paris Convention for the protection of industrial property.

(ix) Using the facilities and expertise of the regional technological institutions to arrive at the common African stand when negotiating with the TNCs.

161. At the Regional Level

Provision by the ECA and other regional institutions of guidance and assistance on request in the following areas:

(i) Establishing or strengthening national, subregional and regional centres for technology;

(ii) Conducting relevant studies and making the results available for the use of African countries. /See (i) Development and Transfer of Technology at the national level/;

(iii) Providing experienced personnel to assist African institutions and local personnel in the negotiation and implementation of projects on requisition and transfer of technology;

(iv) Organizing exchange programmes with Third World countries, and facilitating markets;

(v) Establishment of awards for inventions, innovations, etc., by using the newly established United Nations Financing System for S & T for Development.

162. At the International Level

A. TNCs

(i) Co-operate with African countries by permitting the local R & D centres to undertake a part of their R & D work. In addition, see Development of human resources, at the International Level Paragraph A;

(ii) Refrain from restrictive business practices.

B. Developed Countries

(i) See Development of human resources, at the international level, Paragraph B;

(ii) Encourage TNCs and other technology suppliers to refrain from restrictive business practices;

(iii) Enact laws to nullify existing protection laws preventing African goods and products with technology components from competing in developed country markets;

(iv) Encourage collaborative schemes in consonance with the national socio-economic development plans of the African countries -- such schemes to conform to African environmental standards as well as international standards, e.g., pharmaceuticals, pesticides and fertilizer production.

C. United Nations Agencies and International Organizations

See Development and Transfer of Technology, at the regional level.

TECHNOLOGICAL INFORMATION

163. At the National Level

(i) Establishment of a national centre for Technology Information dealing with:

(a) Importation of technology;
Identification of subsidiaries of foreign firms in the region and elsewhere; compilation of information on the operation of transnational corporations and regular dissemination to business sectors of the economy; data on inputs needed for plants and other technologies and possibilities for local processing or availability; data on low cost and other adapted technology within the country and from other developing countries and regions; data on foreign investments, imports, raw materials, prices of products on the international scene, etc.;

(b) Data and statistics on local technological capabilities and infrastructure;
Data on local capability to obtain, adapt or generate required technology; relationship between demand for goods and services and the efforts to supply adequate technology (the related problems of understanding the character and orientation of transferees); centres capable of giving technical advice and information, the existing engineering consulting firms, etc.;

(c) The provision of above services to various sectors of the economy - especially the productive system.

(ii) Programmes between African and Third World governments to provide fellowships and/or scholarships for 'science and technology' students to study and visit centres of technology development in countries such as China, Japan, India, South Korea, etc., to gain experience and to collect information on the history of technology development in these countries. Such programmes should be planned by inter-disciplinary teams of experts from Third World and participating African countries as African national training programmes involving the universities, R & D institutions, industry, management and business institutions, etc.;

(iii) Encourage the establishment of local scientific and technological associations and societies. National technology information centres should establish ties with other Technology Information Centres of Third World countries to facilitate the flow and exchange of information in all fields relevant to socio-economic development;

(iv) Conduct with the assistance fof ECA, regional institution and other Third World country institutions studies on agricultural and industrial extension services to establish an improved framework for the effective diffusion of technological information to users and the feed-back from them to the R & D and productive Centres;

(v) Active support to and strengthening of organizations such as ESARIPO its ESAPADIC, OAPI, and its CADIB, and PADIS which are African regional organizations in the field of Patent Documentation and Information.

164. At the Regional Level

(i) ECA to give active support to ESARIPO and OAPI;

(ii) ECA, ARCT, AIHTR, ARCEEM, ESARIPO, and OAPI are to give active support, advise and information to African countries wishing to establish a national centresfor Technology Information;

(iii) ECA to establish and maintain contacts with Third World regional Technology Information institutions.

165. At the International Level

(i) International Organizations and United Nations agencies should exchange and share experiences with African countries in all fields of scientific and technological information;

(ii) The United Nations should establish a global Technology Information and Exchange Network with activities in the areas mentioned for the national network but relevant at the global level (international level).

INSTITUTION BUILDING

166. At the National Level

(i) All Governments should establish by law an overall guiding agency with economic and administrative autonomy and provisions for permenent financing to oversee, promote, co-ordinate and direct science and technology activities including those of the productive system;

(ii) A picture of the range of institutions to be established can be obtained from Technological Dependence: Technological capability and Institution Building in Africa. 32/ Every African country cannot be expected to undertake this huge task. ECA should play a significant role in guiding and offering assistance to fAfrican countries in this regard.

167. At the Regional Level

ECA and the regional technological institutions should continue to assist member States in establishing a critical minimum of institutions at the national and/or regional level needed for enhancing endigenous scientific and technological capabilities. It would seem that for lack of sufficient resources at the national level, institutions will continue to be established at the regional level for the time being.

168. At the International Level

International organizations, and United Nations agencies should co-operate with ECA in providing the necessary assistance towards the establishment of regional and/or national institutions which would promote the development of scientific and technological capabilities at the regional and national levels.

FINANCE

169. At the National Level

(i) Establishment of an S & T Development Finance Agency to collect, and administer funds for financing science and technology activities, and to monitor specific activities which by law should be directed at developing athe technological capabilities of the relevant sectors of the economy;

32/ Op. cit.

(ii) Allocation of a definite percentage of the national budget say 2 per cent to the financing of science and technology activities;

(iii) Allocation of the taxes derived from the consumption of a given product or products, e.g., drugs, fertilizers, pharmaceuticals, chemicals, etc., to the financing of science and technology activities, if possible, in those sectors of the economy;

(iv) Assigning a percentage of external and internal credit to science and technology activities especially training activities;

(v) Owners of new industrial investments should be required to make financial provisions for the training of local personnel to assume technical and managerial leadership in the operation of such entrerprises;

(vi) All enterprises (of a certain size in terms of investment, or using foreign inputs or components on a determined scale) should assign a percentage of their net income or turnover to R & D in those enterprises or to the Science and Technology Development Finance Agency;

(vii) Preference should be given by the public sector to the purchase of goods, products, etc., of those firms using local technology, engaged in their own R & D work, and catering for the needs of people in the rural areas;

(viii) All food imports substituting local food items should be taxed and the taxes used to develop local food items, or technologies for that purpose; Each government should set up regulatory mechanisms to penalize defaulters;

(ix) All culprits would be fined to the time of the lost S & T revenue or several times that amount and bank credit withheld from a culprit for a period of time;

(x) The national science and technology development agency should work with the Science and Technology Development Finance Agency (STDFA) in these matters. The one agency will decide on the priorities for which funds collected will be used, with credits lines fixed by the other agency in favour of R & D institutions;

(xi) African Governments should give active support to and participate in the effort to establish a Third World Bank for Science and Technology;

(xii) African Governments should joint with other Third World countries to restructure relevant existing international funding agencies with a view to establishing a better balance and distribution of power within them. Adequate African representation at decision-making level in the newly established United Nations Financing System for Science and Technology Development should be demanded.

170. At the Regional Level

(i) The African Development Bank (ADB) in the spirit of the African Declaration Co-operation, Development and Economic Independence should devote at least half of its programme resources to multinational projects, and assign a definite percentage of its resources to financing S & T projects during the period 1980-2000;

(ii) The Arab Bank for Economic Development in Africa (BEDA) should devote at least one-third of its resources to multinational projects and assign a definite percentage of its resources to financing S & T projects during the period 1980-2000;

(iii) The ECA should seek funds from international funding and development agencies, the UNDP, the newly established United United Nations Financing System for Science and Technology and other financing institutions to finance projects within the region in 1980-2000 which contribute mostly to the strengthening of scientific and technological capabilities.

171. At the International Level

(i) International Funding Agencies, Aid Agencies and other financial institutions and donor developed countries should give priority to those projects that contribute significantly to developing African scientific and technological capabilities;

(ii) Emphasis should be placed, as much as possible, on collaborative or multinational projects of countries within Africa and those between Africa and other Third World countries.

PART III

172. This section of the paper highlights some of the problems that are encountered in a number of significant development sectors in African countries. These problems can be solved if determined local efforts are made to understand the particular socio-cultural milieu under which they develop and to formulate government actions and machinery likely to be most effective in their solution at the national, subregional and regional levels.

173. The situation is essentially that of African governments exercising sovereignty over their natural resources, by ensuring a comprehensive knowledge of these resources, developing capabilities for the study and determination of their characteristics and potential for utilization and development, and for protecting them against wasteful and unproductive exploitation.

174. In the spirit of the alternative development strategy proposed for the region in the preceding paragraphs, special emphasis should be laid, in the cases presented hereunder, on those efforts directed towards satisfying the needs of the majority of the population in general and of the rural population, in particular.

175. Solutions would require the development selection, transfer and adaptation and utilization of appropriate technologies by the countries concerned, to promote the processing and conversion of raw materials, to prevent their damage and deterioration, and to stimulate their economic development for the benefit of all.

176. In this context, special attention should also be paid to the development of manpower, and the establishment of appropriate institutions 33/ with adequate linkages embracing government, the productive and financial sectors of the economy and the scientific and technological system.

177. The assistance of regional organizations such as the ECA, ARCT, AIHTTR, ARCEDM, ARSO, ESARIPO, OAPI, ADB, ABADEA, and international organizations and UN agencies should be sought when necessary. It is the duty of African governments to see to it that assistance provided in response to such requests are properly co-ordinated at country level and appropriately integrated with their national development plans.

178. Finally, the experience of the late developers (e.g., China, Japan, Mexico, Brazil, USSR etc.), in the various fields should be tapped at every possible opportunity and adapted to local conditions.

33/ R & D directed to solving development problems to be given top priority.

FOOD AND AGRICULTURE

General

179. African economies are predominantly agriculture-oriented and agricultural activities take place invariably in the rural areas where a majority of the people live. Food production also takes a large share - 89 per cent - of agricultural activity. However, good production in Africa per capita has been declining since the 1970s, resulting in a phenomenal increase in food imports and in world food aid to African countries. The trend will continue unless drastic measures are taken by African governments to reverse it.

180. Several factors have contributed to this undesirable situation, and these are represented in the following critical areas: the availability of water for irrigation; the natural and biological hazards (trypanosomiasis and onchocerciasis); the farming systems which are characterized by the small size of peasant farms; the absence of improved crop and livestock practices; the absence of preservation and conservation techniques for harvested crops; 34/ lack of adequate methods of processing, transportation and distribution of agricultural products, an acute shortage of skilled manpower, and inadequacies in government services and fiscal policies.

181. Underlying all these factors, which are obstacles to the development of food self-sufficiency in Africa, the low level of technological capability takes a major share of the blame. In addition, as was noted by the Tenth FAO Regional Conference for Africa, another reason for this insufficiency in food supplies is the fact that"current production patterns were largely designed to feed manufacturing industries in the industrialized world, and that much infrastructure, including research was geared to this objective. Therefore, the Conference agreed that agricultural production should be restructured to produce goods required in the Region; that trade patterns should be restructured to suit local requirements; that as socio-cultural background tended sometimes to impede co-operation in trade, there should be more trade in raw materials and not finished products in order to overcome this socio-cultural barrier". 35/

182. The FAO Conference further noted that in order to arrive at a solution to the problem "emphasis should be placed on providing incentives for increased food production.....development of the traditional sector should be accorded high priority.....through such measures as assured markets and guaranteed prices; selective input and product subsidies, tax incentives and fiscal policy; package schemes of improved seeds, fertilizers, chemicals and other inputs; the prevention of post-harvest losses; expanded and improved storage facilities; the development of livestock rangelands and irrigation and land-reclamation programmes for swamp land and tsetse- and similium-infested areas..... increasing the production of protein rich foods, such as dairy products, poultry and fish thfough the expansion of fish farming".

34/ According to Africa Magazine, July and September 1977 issues, the losses resulting from inadequate methods of storing, processing and marketing may be as high as 50 per cent and in some cases even higher.

35/ Report of the Tenth FAO Regional Conference for Africa, Arusha, Tanzania, 18-28 September 1978, ARC/78/REP, FAO, Rome 1978.

183. There is a need, therefore, to establish at the country level a policy for integrated rural development in agriculture which would be based upon the need to meet African nutritional requirements as cheaply and effectively as possible. It would be necessary within such a context for Africa governments to make provision for the development of scientific and technological machinery at the national and regional levels for the execution of appropriate surveys and research programmes to reduce food losses, improve nutritional values of local foods; evolve suitable techniques including the production and/or acquisition of tools, equipment, other relevant machineries including servicing for the harvesting, processing and preservation of the food products; provide utilities in such fields as rural electrification, water supply and transport; a high level of investment; the provision of adequate agro-service structures aimed at bringing techno-agricultural inputs within the easy reach of farmers and the feed-back of the impact of these to the agricultural and technological R & D centres; the development of appropriate manpower, and the establishment of food and agro-allied industries. The financial implications of such a programme are significant. Funds should therefore be mobilized not only at the national level. Asiistance should be obtained from funding agencies such as IFAD, ADB, ABADEA etc.

184. An illustrative listing of the kinds of problems to which science and technology can be applied in the food crops, animal and fishery sectors is presented below:

Food crops

185. Problems: the preparation, protection and conservation, and increase of yield-potential of the soil; the selection and development of special strains of crop depending on the ecological conditions; weeding, planting, and harvesting; the preservation, conservation and distribution of harvested crops.

186. Science and Technology inputs: to solve the above problems it would be necessary to take inventory of the soil resources and study soil science, erosion control, develop appropriate methods for irrigation, and combat drought problems; develop local methods or adapt imported methods of manufacture of agricultural chemicals including fertilizers, pesticides and herbicides so as to keep the soil and the crop in very good condition; the local manufacture of agricultural implements to ease the physical drugery of the work of the farmer, especially the rural women in such chores as water collection, fuel collection and grain pounding; research and development of special crops, improved seeds, flour, etc. - and appropriate farming systems and practices to increase yields after overcoming the problems of insects, rodents and other pests, the development of special storage and processing systems - e.g., drying packaging, canning etc., planning the physical infrastructure for the transportation and distribution of harvested crops.

Animal resources

187. Problems: the need for adequate protein supply for the population; problem causing insects (such as the tsetse fly) and their ill effects on the animals; shortage of food for the animals due to lack of water generally and, in particular, the recurrence of drought; the breeding of increasing stocks of animals so as to maintain an adequate supply for the population; the preservation, conservation and distribution of meat at reasonable prices; the provision of dairy products; the development of live-stock rangelands; and the organization of the nomadic population.

188. Science and Technology inputs: careful study of the breeding habits of the tsetse fly and other insects with a view to eradicating them or reducing their harmful effects on the animal population; breeding the right kind of animal to resist the hazards (e.g., tsetse fly, food shortages, inadequate water supplies) of the environment; management and maintenance of the quality of improved stocks of animals; the development of adequate processing and preservation (e.g., refrigeration techniques) methods; the planning of the physical infrastructure for the transportation and distribution of processed meat at reasonable prices; careful study of the living habits of the nomadic population to evolve suitable systems for organizing both themselves and their herds.

Fishery resources

189. Problems: the possibilities of overfishing in coastal areas, and in inland waterways; the need for an adequate supply of protein for the population; preservation and conservation of catches; transportation and distribution problems.

190. Science and Technology inputs: The development of techniques for breeding and preserving fishery resources in inland waterways; the development of techniques for deep-sea fishing since coastal reserves are rapidly depleting; the development of aqua-culture (i.e., oysters, sea weeds, shrips, salmon etc.); the manufacture of fishing gear and boating facilities; the development of techniques for the preservation and conservation of catches (e.g., refrigeration etc.); the planning of physical infrastructure for the transportation and distribution of fish at reasonable prices.

191. In all these food and agriculture sectors, adequate linkages between and among the stipulated activities and a proper system for the collection, storage, retrieval and dissemination of information, not forgetting the education and training of cadres of professionals ranging from the soil specialist, agriculturist, agricultural engineer, technician, through the extension worker to the literate and illiterate farmer, should be provided. The crucial need for supplying adequate and appropriate amounts of energy and water should not be overlooked. (See energy and water resources below). A similar infrastructure is required for the adequate development of forest resources and other sectors (See discussion below).

192. "A well-conceived technology policy (for the development of) 36/ this industry can contribute to multinational improvement by reducing waste and spoilage and avoiding seasonal disturbances, by improving distribution to urban communities that are increasingly distant from the point of agricultural production, by increasing variety of food and enriching the diet of target groups in the population, by providing new products while making more effective and environmentally sound use of agricultural raw materials and by increasing the incomes of the poor". 37/

193. A modest start in the right direction has been made jointly by ECA and FAO in response to the call of the four Conferences of African Ministers of Industry to accord food and agricultural industries the highest priority. A survey subsequently conducted in African governments showed that, "training", development of cereals (sorghum and millet, in particular) and edible oil processing industries, received the highest overall priority. The fruit and vegetable, dairy and animal products, and animal food processing industries also have high priority - as do the non-food industries based on natural fibres, hid skins and other animal by-products". 38/

FOREST RESOURCES

194. Africa is endowed with reserves of forest resources. But the current pattern of exploitation of this resource in land-use planning as high-yielding farmlands and as a source of fuel and energy for the rural and some urban ar areas, as raw material input into the manufacture of building, educational and paper materials leaves large areas of forest land destroyed or significantly depleted. This situation has resulted in the desertification of some African countries causing considerable erosion of soil nutrients. Most times the process is irreversible with little prospect for the future renewal of this important resource.

195. Africa possesses about 8 per cent of the standing volume of closed forests in the world, yet in 1973 African countries produced only 0.4 per cent of wood panels, 0.8 per cent of sawn wood and 0.2 per cent of wood pulp. Most of their activities in this field have been disorganized, and oriented to the production of fuel and farmlands in the rural areas and in producing raw materials for export in the form of sawn logs and veneer, etc., with little attention to secondary products for joinery, woodworking and furniture. Proper management of this resource has therefore been largely ad hoc or woefully inadequate.

196. However, because of their renewable nature, forests, if properly managed, can assist continuously in satisfying the basic human needs for goods and services such as fuels, energy, wood products, food recreation, water-shed-management and employment.

36/ Words in bracket are not in text quoted.

37/ Technology policies in the food industry: issues for research UNCTAD, TD/B/C.6/40, United Nations, 1978.

38/ Progress Report on the Implementation of the LIMA declaration and Plan of Action at the regional level: Sectoral Programmes for Development of Basic Industries ECA/CM I/FCIA.6/WP/1, July 1979.

197. There is an urgent need therefore for the creation of firm policies and viable research and other programmes relating to the technology of exploitation utilization, protection and conservation of forest resources. This would require improved legislation and machinery for effective planning and regulation, training of manpower, and the establishment of appropriate institutions at the national, multinational and regional levels for the development of technical and other capabilities in this field. ECA and FAO have developed a forest industries programme with financial support from UNDP to integrate two aspects of forest industries, namely, raw materials production and secondary forest aspects with a view to increasing the value added retained by African countries. 39/

198. An illustrative listing of the kinds of problems requiring scientific technological inputs are presented below.

199. Problems: inventory of the kind and potential of forest resources available, deforestation due to man-made activities, forest diseases, the effect of the environment (tropical) on forest resources, the harmful effects of certain extraction and processing methods, over-exploitation of certain species due to lack of proper management techniques, storage, transportation and distribution techniques, the problem of creating recreational facilities within forests, lack of adequate manpower.

200. Scientific and Technological inputs: the need to use remote sensing techniques to survey the forests for inventory and interpretation of the data collected; the mounting of research programmes to combat the harmful effects of the environment; soil science research to increase the nutritional value of depleted soils; the introduction of new plantation species for increased productivity through tree breeding and fertilization techniques; the promotion of indigenous research and study of native species in particular ecological areas; the possible labour-intensive techniques and the manufacture of equipment for clearing, planting, logging and processing as current saw mills are not adequate for small logs; the development of adequate treatment or management techniques through the most appropriate system of silviculture and management; the development of storage methods which could prevent the warping and deterioration of felled trees and processed material; establishment of preservation and drying standards; the setting up of physical infrastructure for planning operations, transport networks, and distribution system; designing recreational facilities; development of appropriate industries for domestic consumption; training of manpower; the use of adequate information diffusion systems; negotiating the transfer and adaptation of suitable machinery for industries.

201. All of these activities call for such facilities as adequate supplies of water for irrigation systems, power driven machines etc. Therefore a programme of this sort should be linked with the developeent of water and energy resources to ensure co-ordinated industrial development in the rural areas. Possibilities

---

39/ Ibid., ECA/CAI/FOIA.6/G/UP/1 Page 4.

for co-operation at the subregional, regional, interregional and international levels should be explored. There is, for example, the work being currently undertaken at the Forest Products Laboratory of Madison in Germany on the use of mixed tropical hardwoods for pulp and paper. African countries should seek to involve their scientists and technologists in studies such as these. They should also give active support to ECA programmes, and those of other relevant regional and international organizations. The possibility of setting up a regional programme for studying the aggregate quantity, quality and potential for development of forest resources should be explored.

WATER RESOURCES

202. It is an indisputable fact that the provision of safe water in many urban areas and over vast rural areas in Africa is far from satisfactory. As has been illustrated in the preceding paragraphs, if African development efforts directed at improving the quality of life of the rural areas are to succeed, then African countries should take appropriate measures to provide safe water for all uses - human and livestock consumption, waste disposal, agriculture, industry, transport, drought control etc.

203. The problem is especially acute in the rural areas because of its relationship to food production. In these areas, water-borne and food-propagated diseases such as cholera, amoebic and bacillary dysentry are rampant; other types of polluted water are unfit for human, animal and crop consumption; due to the uneven distribution of rainfall, the generally low run off coefficient and high coefficient of evaporation of surface water, the availability for all uses in Africa is the lowest in the world.

204. Because the low availability and the continually increasing demand, there is an urgent need for African countries to mount water development programmes with appropriate technological inputs (various technologies can be utilized) to assess future needs, to treat available sources, search for new ones, and improve on delivery systems.

205. This would involve the creation of effective government policy in the planning, design, operation and maintenance of projects; the provision of adequate legal machinery; the establishment of appropriate research and development programmes; institutions for training manpower in sufficient numbers at all levels, for the manufacture of local equipment, for the development and adaptation of technology, for negotiating technology transfers, for repair and maintenance of equipment, for collection and dissemination of water data, for undertaking surveys and studies, for the generation of funds etc., with adequate linkages ranging between the governmental and productive sectors.

206. The need for co-operation at the subregional, regional, and interregional levels in the fields of legislation, river basin development, conservation, exchange of information, research projects etc., should be given top priority.

207. An illustrative listing of the problems in this field which will require scientific and technological inputs for their solution is given below:

208. Problems: inadequate supplies of water for human and animal consumption, and agricultural and industrial uses everywhere especially in the Sahel region; locating and assessing available sources; elimination of water borne diseases; elimination of sources of water pollution; treatment of salination problems of island countries; inadequate delivery systems; inadequate storage systems; lack of adequate manpower; technology infrastructure; inadequate national water policy.

209. Scientific and technological inputs: Comprehensive surveys and feasibility studies requiring the use of transferred or locally developed technology, geophysical techniques and equipment (e.g., exploration, measurement and drilling techniques and equipment) to locate groundwater, hydrpower and watershed resources in humid, semi-arid and arid areas; scientific interpretation of the results of such studies to assess the quality and quantity of the supplies using appropriate technologies; studies and development of treatment techniques and equipment including standardization; the development of methods and equipment to combat the salination problem and provide water for several purposes; the development of improved delivery systems using local materials (e.g., packed stones to form ducts for irrigation purposes, design and manufacture of hand pumps etc., for community water supply); the development of storage systems using local materials (e.g. timber watershed management, domestic and industrial containers); training of sufficient number of scientific and technological manpower at all elevels (e.g., civil engineers, technicians specialising in fluid mechanics and hydraulics, repair and maintenance personnel, water management experts, marketing specialists for demonstration and sale of equipment, etc.),; establishment of an adequate scientific and technological infrastructure incorporating appropriate policy and legal provision.

210. As has been mentioned before, sound socio-economic development will result if the above system of activities and structures is fully integrated with the other sectors of the economy (e.g., food and agriculture, development of forest resources, energy use etc.....). African governments can request assistance from regional organizations, such as the ECA, in seeking solutions to not only national problems as already outlined, but also to international problems of co-operation such as those outlined earlier.

211. It will be necessary here as in the other cases to locally allocate funds for water programmes, and to tap external sources of funding such as ADB, UNDP, ABADEA, and the new UN Financing System for Science and Technology for Development.

ENERGY RESOURCES

212. Africa has considerable energy resources such as hydrocarbons, coal, solar, geothermal and hydropower. Her potential for hydropower and nuclear energy has been assessed.

213. The continent's recoverable coal resources are estimated at 33.5 billion tons against a production of some 80 million tons per year; the proven preserves of petroleum are estimated at about 10 billion tons which represents some 11 per cent of the world's reserves; reserves of natural gas are estimated at 5,500 billion cubic metres whereas its production is very low; with over 250,000 metric tons of uranium reserves, Africa exports its production in full; its production of petroleum is five times its consumption; its technically exploitable hydropower potential is 1,630 billion Kwh per year, or one third of the world's hydro electric resources; African prospects for solar enerty are practically limitless; large areas have good prospects for development of geothermal energy and there is a considerable potential for utilization of biomass as a source of energy. 40

214. However, all this abundance of energy resources in Africa is yet to be developed. A large share of the current activities in this field is in the hands of transnationals which possess the energy technologies, have access to financial resources, skilled manpower and the necessary infrastructure.

215. Because Africa is in dire need of industrial development - a process in which energy is an indispensable tool, each African country must strive to reverse the undesirable trend and develop an energy policy which would enable it to do the following:

- make an inventory of energy resources both land and sea-based
- develop and utilize energy resources with priority given to energy technologies that exploit human and material sources in the rural areas for integrated rural development
- develop new and renewable sources of energy in areas such as solar, wind and biomass by promoting R & D activities
- set up the necessary mahhinery for the transfer and adaptation of technologies for surveying, exploring and exploiting primary energy resources
- develop energy technologies
- train manpower in sufficient numbers and levels
- effect regional agreements and co-operation arrangements among neighbouring and other African countries by supporting the strengthening and establishment of subregional and regional institutions capable of forecasting and planning energy resources development, carrying out experimental work on the most promising forms of new energy sources, studying the practical application in the new technological fields, training required personnel and making economic and technical recommendations on the practical applications of new sources of energy.
- generate funds locally and from external sources

40/ Measures for the Implementing of the African Strategy for the Third United Nations Decade: Energy Resources Development and Utilization, paper prepared by ECA, Energy Resources Unit, 1980.

- give active support to existing regional institutions in solar energy e.g., Regional Centre for Solar Energy Research and Development

- request appropriate assistance from ECA, other regional institutions, international organizations and UN agencies.

216. Full advantage has not been and cannot be taken of available energy resources to create an economic climate conducive to industrial development largely because of the low level of technological capability and lack of trained power and infrastructural services in this field. The unfortunate pattern of current consumption also adds to the problem because it favours the urban population who get their supplies from commercial sources. The rural population however predominantly relies on non-commercial sources of supply (wood from forests) which are largely unorganized and subject to extinction because of widespread deforestation. "There is therefore a need to integrate non-commercial energy sources into the organized sector by devoting investment and management efforts to it (for example biogas plants using dung and wood plantations) thereby assuring the rural energy supply on a sustainable basis". 41/

217. This trend in the rural areas can also change significantly when African countries realize that energy supplies influence the rate of development of all other sectors of the economy. Without adequate supplies of it, the operations of the productive machinery of a country in such sectors as agriculture, transportation, and industry etc., can cease to function effectively. An impression of the sort of scientific and technological inputs required is provided in the report listed below. 42/

218. In addition increased effort shall be made to produce electricity from small-scale low-head hydroelectric generators which ocould be installed in many locations of rural Africa as an alternative to a centralized system of supply to utilize the existing untapped hydropotentials. The experience of countries like the People' Republic of China in the development, installation and management of such units for such rural electricfication programme should be invaluable.

41/ Appropriate Industrial Technology for energy for rural requirements, UNIDO Monograph on Appropriate Industrial Technology No.5, United Nations, New York, 1979.

42/ Op. Cit., Measures for Implementing the African Strategy for the Third United Nations Development Decade etc.

INDUSTRY

219. The industrial sector is very important for all countries in the region. The activities that take place within it involves the conversion of raw materials into semi-finished and finished products.

220. "In Africa, as a result of its colonial past that relegated it to the role of supplier of raw materials for the factories in the metropolitan countries and captive market for their industrial products, industrialization has been characterized by isolated efforts which have resulted in incoherent and heterogeneous units, with very low value added and little or no intra or inter-sectoral dynamic impact. As a consequence, Africa could neither meet the basic needs of its growing population, nor make use of its abundant resources to its own advantage.

221. "But even post-independence industrialization strategies and policies have not improved situation. Heavily dominated by foreign agents of production and distribution, the "industrial" sector is made up mostly of an odd assortment of light consumer goods industries (paint mixing, beverage bottling, assemblies, etc.) which cater only to the needs of a minority; perpetuate the countries dependence on and exploitation by the outside world; have not resulted in an optimal development of natural resources; and they have neither reduced the outflow of resources for the economy as a whole, nor reduced prices to the consumers. Africa, is a continent that produces what it does not consume and consumes what it does not produce. Clearly, therefore, there is a need for change in approaches to industrialization.

222. "On the industrial front proper, it is essential that the selection of product lines be effected by the African countries themselves, and no longer by foreign organs or enterprises, observing the following criteria as guides: produce the goods consumed locally first, then those needed by other local industries and sectors, and those which can be sold to other developing countries (especially within the African region) - before trying to satisfy the "world market", for African industries should meet African needs first.

223. "The logical sequence of events is to start with the basic industries and the equipment goods industries -- the "industrializing" industries which produce inputs and capital goods for other branches of industries and other sectors -- and the basic agriculture-based industries (food-stuffs, oil, sugar, textile). After these three priority areas have been developed, it would be easier and profitable to build and/or expand the other consumer goods industries. No standard timetable can be fixed, because this would of course be a function of each country's resolve and commitment to development, natural endowments, present stage of industrialization and size. 43/

224. A step in the right direction was taken by the African Ministers of Industry at their fourth conference held at Kaduna, Nigeria, in November 1977. The Conference recommended that priorities be given to the following areas in the order listed:

- industrial policies;
- food and agro-allied industries

43/ Regional Symposium on Industrial Policies and Strategies for Internally self-sustaining development and diversification and collective self-reliance

- building materials and construction industries;

- engineering and basic metals industries;

- chemical industries.

Food and agro-allied industries

225. The nature of the scientific and technological problems to be encountered in the food and forest-based industries was discussed in the earlier paragraphs.

Building materials and construction industries

226. The peoples of the rural areas of African countries live in the most deplorable conditions - as far as the provision of adequate shelter is concerned. The houses are generally badly designed and constructed by the occupiers themselves from inadequately processed local materials.

227. In the urban areas, although decent housing is available, construction costs are prohibitive primarily because a large portion of the building materials used are imported.

228. But the construction industry plays such a significant role in many African economies; about 30 to 35 per cent of the output of the industry is accounted for by dwellings, the rest by manufacturing, transport, roads, health, education and other public services.

229. The major concern of most governments, however, is the urban housing problem and the need to construct low-cost housing. But the programmes set up in the majority of cases suffer from the high cost of buildings and bad construction practives.

230. In 1970, according to ECA compiled figures, Africa spent US$5,228 million on construction and of this amount US$1,500 million was paid in foreign currency for imported building materials. Accumulated investment in the 1965-1972 period amounted to US$25,650 million and of this amount US$14,850 million accounted for building materials inputs. It has been estimated that the continent can save over US$1,300 million a year, if current practices of hiring foreign contractors and importing building materials are ceased. 44/

231. The industry has many problems which can be categorized as follows: 45/

44/ First report of the Team of Experts on the Construction Industry and building Materials Industry Development Programme, ECA/CMI/FCIA.4/WP.5

45/ Ibid. p.7

(i) a high component of imported raw materials;

(ii) the technology employed is transferred technology and often inappropriate in the conditions which prevail;

(iii) existing indigenous raw materials are not used. Even in cases where stone or clay is available in large quantities, hollow cement blocks produced from imported cement are preferred. In cases where dolomite is found locally, cement is used as mortar. Where timber is found in abundance, the manufacture of cement blocks is encouraged;

(iv) low capacity utilization due either to lack of good management and technical know-how or to an irregular supply of imported raw materials;

(v) effort to improve and commercialize traditional building material.

232. The possibilities for scientific and technological inputs into this industry are vast, and range from the efforts to substitute adequate local building materials in the construction of wall, roof, etc., in the manufacture of sanitary ware, electrical fittings and finishes, to the local manufacture of iron and steel products such as bars, rods, door frames, profiled sections, tubes, water tanks, steel windows, etc.

233. It is therefore necessary to devise machinery at the national, sub-regional and regional levels to develop this very important industry. In this context, the possibilities of using local iron and steel workshops to manufacture products such as those described above and expand their operations into adapting imported technology and the production of spare parts and components for locally developed and imported machinery should be examined. The training of manpower to play the roles of contractor, structural engineer, consultant, plumber, welder, and materials expert for the geological exploration, appraisal and exploitation of raw materials should be given top priority.

234. The establishment of adequate repair and maintenance units, technological information systems, R & D centres, etc., should be undertaken.

235. For a comprehensive set of recommendations see E/CN.14/HUS/35/ 46/ and the progress report on the work done by ECA to set up a regional programme for the development of building materials and construction industries. 47/

46/ Report of the Meeting of African Experts of Building Materials and Construction Industries, E/CN.14/HUS/35, August 1979.

47/ Op. cit. ECA/CMI/FCIA/5/WP.1/P.5.

Engineering, basic metals industries

236. The development of engineering and basic metal industries is to be encouraged by African countries because of their potential for creating the necessary backward, forward and lateral linkages with the rest of the economy. These industries can be utilized to generate employment, develop technology and skills, to produce goods for export, parts and components for keeping them in good repair, machinery for food and agro-based industries, increase value-added and foreign exchange earnings.

237. This chain reaction which has just been described is very necessary for the self-reliant and self-sustaining integrated development which has been advocated in the earlier paragraphs of this paper. But Africa has not yet embarked on a path to create such industries on a large scale and derive from them the benefits mentioned. However, significant structural shifts took place in the period 1960-1975 from traditional branches of engineering to the development and manufacture of selected intermediate products: steel rods and pipes, fabricated sheet metal tankers, road vehicle bodies and trailers, railway wagons, automative spare parts such as filters, radiators and exhaust pipes, machine tools, improved foundries and electrical equipment, etc., In many of the countries visited by the ECA/UNIDO mission except in Egypt and Nigeria, no integrated approach has emerged for developing the engineering industries sector of the economy 43/ So far the continent's output of metal and engineering products as a ratio of total world production is 0.02 according to figures recorded between 1955 and 1970.

238. Part of the reason for this meeting failure may be attributed to the inability of national governments to make the kinds of capital investments necessary and develop national markets to utilise the products. The manufacture of capital goods, such as machine tools, for example, requires the provision of foundry facilities, forging, heat treatment, machine shop, tools and parts and procurement of accessories. The current tendency is to import capital goods, (e.g., turn-key plants with all their adverse economic and social impacts) against earnings derived from the export of cash crops and minerals. Another problem is the lack of technological capability in terms of the availability of local technology, skilled manpower to undertake feasibility studies, design, implement and manage projects in these fields; the use of expatriate technical management personnel, exploitation by unscrupulous foreign companies, banks and financing institutions, the lack of operation and maintenance personnel, etc.

239. It would seem, therefore, that subregional and regional co-operation in this field should not be ruled out if the problems of economies of scale are to be eliminated. Illustrations of the scientific and technological inputs necessary to solve problems in this area are given below.

43/ Report of the First ECA/UNIDO Basic Metals and Engineering Industries Development Programme, ECA, 1970.

240. Basic metals industries comprise such industries as iron ore smelting and alumina production. It would be necessary, therefore, to be knowledgeable about, geology and geophysical techniques for exploration, extraction and evaluation of ore beds; to have sufficient numbers of people trained at various levels in fields such as metallurgy, engineering (design, materials engineering), physics, geology, materials testing, to have appropriate institutions for negotiating the transfer of technology for adapting imported technology and developing new ones, R & D laboratories, standards and quality control facilities, workshops for repair and maintenance of equipment, capabilities for collecting, storing and disseminating information on production technologies, marketing conditions, TNC operations, sources of financing, etc. The development of engineering industries which produce industrial machinery and equipment for manufacturing machine tools, agricultural machinery, drills, lathes, presses, looms, etc., will require similar kinds of scientific and technological inputs as the basic metals industries.

241. Due attention should be paid to the upgrading, expansion and co-ordination of production units in many African countries such as the workshops of motorcycle and other vehicle mechanics, of building tradesmen, of electrical soldering technicians, of plumbing technicians, of carpenters, etc., and railway workshops. This proposal should be given top priority because these workshops are the nodal points of growth for technological adaptation, and training of technical entrepreuneurs and training of the school drop-out population into useful citizens producing spare parts and other accessories for the development of industries.

242. Every effort should be made to assist these workshops by giving them informatiohonon areas of need, various sources of supply of materials, etc., helping them to draw up supply contracts, and providing necessary training.

243. ECA and UNIDO mounted a mission in 1979 to various African countries in compliance with the provisions of the Lima Declaration and Plan of Action 49/ and the wishes of the 1977 fourth Conference of African Ministers of Industry in Kaduna, Nigeria, as a basis for the development of a Basic Metals and Engineering Industries Development Programmes. 50/ Progress report on the programmes has been submitted.51/

244. The mission proposed that the following institutions should be established with ECA/UNIDO assistance:

49/ Lima Declaration and Plan of Action, March 1975, UNIDO PI/30., para. 50 (f), (i) and (iii), pp. 10 and 11.

50/ Report of the First ECA/UNIDO Basic Metals and Engineering Industries Development Programme, ECA, 1978.

51/ Op. cit., ECA/CHI/ECIA.6/WP.1/pp. 2 and 3.

(i) African Centre for Repair and Maintenance;

(ii) African Centre for Iron and Steel Industry;

(iii) African Centre for Non-fenous Metals Industry.

Chemical Industries

245. The chemicals industries which are of relevance to Africa's industrial development comprise basic chemicals, agricultural chemicals (fertilizers, pesticides), petro-chemicals and pharmaceuticals. The total import of all chemicals in the year 1977 amounted to $US4.8 billion. This amount represented a five-fold increase (including the effect of inflation) from 1970 when the imports were hardly $US1 billion. Africa currently produces a small amount of basic chemicals (e.g., sulphuric acid) for fertilizer manufacture or pulp and paper production and mineral extraction 52/

246. This industry, like the basic metals and engineering industries, interacts favourably with agriculture to produce the necessary backward and forward linkages which are essential for industrialization. However, for the same reasons previously advanced, Africa has failed to develop such industries widely and continues to import chemicals at great cost to the national reserve of foreign currency. There is need therefore to treat the problem with urgency.

247. The single apparent solution to the problems in this industry will be for countries to undertake multinational projects to create reasonably sized markets and generate adequate funds both internally and abroad to maintain the industries. However, those that have the necessary resources and markets can mount national projects and programmes to exploit them. 53/

248. The ECA/UNIDO mission proposed the creation of the following centres:

(a) For pharmaceuticals: Two multinational pharmaceutical companies one for East and the other for West Africa;

(b) For Basic Chemicals: A Chemical Technology Centre;

(c) For Fertilizers and Pesticides: A Fertilizer and Pesticides Development Centre;

52/ Report of the First ECA/UNIDO Chemical Industry Development Programme, ECA, 1970.

53/ See Report of ECA/UNIDO Mission on the Chemical Industry Programme. Ibid. pp. 10 and 24.

(d) For Petrochemicals: Three Centres for the Development of the Petrochemical Industry one for East. one for Central and one for West Africa.

249. The characteristics of the chemical industry are: high capital intensity, low labour intensity, complex technology calling for a high degree of professional skills, high sensitivity to economies of scale, high risk of process absolescence, need for integrated product planning - i.e., product from one plant can be used as raw material for another plant, need for economic selection of process routes out of several alternatives, high temperature nand pressure processes calling for precise monitoring and control, high risk of process accidents calling for high priority for industrial safety practices. 54/ In addition, the raw materials to be used may be found in local mineral deposits or have to be imported; services such as electricity, fresh water, cooling water and safe disposal of the effluent to prevent pollution must be provided; a market must be available.

250. Because of the nature of the industry it means that African countries as a group or individually may for some time to come continue to import technology in most of its undesirable forms. Countries have to take steps, therefore, to ensure that such technology is transferred under the most favourable terms.

251. An adequate infrastructure of institutions will have to be established at the national or regional level to train high level process engineers, technologists, managers, professional operators and other personnel such as chemists, geologists, surveyors, (to determine the total extent of proved resources in local mineral deposits, their quality and suitability), botanists, pharmacologists, biologists, plasma specialists, quality control inspectors, project design and implementation personnel to undertake marketing and engineering studies such as pre-feasibility and pre-investment investigations; the use of local consultancy firms should be encouraged; legal and technical machinery should be set up to regulate standards of production, safety, the activities of transnational corporations to the benefit of the country, the use of foreign experts, the negotiation of the purchase of technology under reasonable terms, e.g., (the suitability of the technology, the exclusiveness or non-exclusiveness of the use of the technology, the process and engineering guarantees to be provided by the supplier, the type of contract, etc.,) ensuring that local institutions for technology assessment exist, the provision of adequate linkages between government, the productive and the financial sectors should not be overlooked.

252. Every effort should be made to establish, inter alia, repair and maintenance workshops, R & D centres, industrial apromotion centres, adequate physical infrastructure to ensure that plants will work at design capacity. In this way African countries would ensure that the technology being transferred will be of benefit to them.

54/ Ibid., p.4

253. For financial and technical assistance with many of these projects, ADB, ABADEA, UNDP, the newly established United Nations Financing System for Science and Technology for Development, the African Industrial Development Fund, the African Regional Centre for Technology, the yet to be created African Centre for Consulting Engineering and Management, the African Regional Centre for Engineering Design and Manufacturing, the African Institute for Higher Technical Training and Research, the African Regional Organization for Standardization, the African Regional Industrial Property Organization, the ECA, UNIDO and other United Nations and international organizations should be contacted.

254. For a comprehensive picture of the chemical industry in Africa and proposals to develop it, the reader should consult the ECA/UNIDO Report. 55/

255. Attention should be drawn, in addition, to current methods of fertilizer production which are such that only the rich farmer can truly afford the expensive end product. The peasant farmer on the other hand either pays for his quota by bartering his meagre produce to government suppliers under great strain or he can receive fertilizer at costs heavily subisdized by the Government. Neither of the latter methods of procurement is economical for any African country.

256. In order to reverse this trend, African countries should in the quest for a viable alternative, pay due attention to the experience of China's rural people who have discovered simple techniques for fermenting vegetable debris, animal and human waste products from which not only inexpensive fertilizer can be obtained but also gas for cooking and lighting.

TRANSPORT AND COMMUNICATIONS

257. The African strategy for the development of this sector is explicitly presented in document E/CN.14/749 56/ which forms the basis for the United United Nations Transport and Communications Decade in Africa and elaborated f further in the document E/CN.14/726 57/.

258. The main objective is to establish self-reliance in fields such as maritime transport, region-wide inter-modal transport network linking roads, railways, inland waterways and air services; in the telecommunications through the Pan African Telecommunications Network.

55/ Ibid.

56/ Resolutions and Decisions adopted by the 15th Session of the Conference of Ministers on the African Development Strategy for the Third United Nations Development Decade, E/CN.14/749, January 1980.

57/ United Nations Transport and Communications Decade for Africa, 1978-1988, E/CN.14/726, Vol.1 and E/CN.14/726/Add.1, Vol.II, Parts 1 to XII, May 1979.

259. The technological challenges are many developing techniques for road construction and maintenance not only suited to the local environment but at economic and sustainable costs (involving research and development of design standards, standards for new road building materials, etc.); developing technologies for cargo handling at ports, local manufacture of transport equipment (boats, parts of ships, implements used on board, etc.) and for construction of ship-yards with the attendant establishment of design standards and quality control; local manufacture of telecommunication components and equipment (involving the introduction of uniform standards for the manufacture of such equipment); research into new communication technologies with a view to developing effective methods of communicating ideas to the general populace especially those in the informal sector, etc.

260. The necessary manpower will have to be trained: civil engineers, maintenance engineers, aeronautical engineers, railway engineers, nautical engineers, telecommunication engineers, air-line pilots, marketing experts, management personnel, middle level technicians, etc.

261. Institutions will have to be set up to for the repair and maintenace of equipment; R & D centres; technology development, transfer and adaptation centres to encourage and regulate the development and flow of technology and to monitor and control the activities of the transnational markets, etc; and development of the physcial infrastructure for transport and communication at the national, subregional and regional levels.

262. Assistance with financing of the infrastructural projects can be sought from the ADB, the World Bank, UNDP, the newly created United Nations Financing System for Science and Technology Ffor Development, IBRD, etc. Assistance of a technical nature can be obtained from organizations such as the International Road Federation, the Transport and Road Research Laboratory of Great Britain, the International Telecommunications Union, the Inter-Governmental Maritime Consultative Organization, ECA, etc.

HEALTH

263. The importance of this sector lies in the fact that through the development of a healthy work force and that portion of the population with great potential for socio-economic development, it provides a principal motive force for the other sectors.

264. There are, in Africa, several problems in this sector which will require science and technology inputs for their solution and these must be thoroughly investigated through research and development processes. Among these the following can be listed as priority areas: the provision of clean water for human consumption; control of various diseases such as cholera, amoebic and bacillary dysentry transmitted by water and food, malaria, small-pox, trypanosomiasis, virus diseases, schistosomiasis, onchocerciasis and leprosy; improvement of the nutritional value of food items; maternal and child care; the inability of the average person to have access to needed food items, vitamin and other drugs and health care because of the high cost of such articles and services.

265. Solutions to these problems can be arrived at by developing "trouble shooting" techniques which will assist in the diagnosis of diseases so as to arrive at a cure for the ailments at reasonable cost.

266. It would mean therefore that efforts should be directed not only at training manpower at all levels but at establishing adequate physical infrastructure for the collection of health data and information at local, subregional and regional levels, for negotiating transfers of technology for adaptation of imported technology, for developing technology through R & D, for the smooth transmission of health services, for providing markets, for medicinal products for repair and maintenance of equipment, etc., with adequate linkages among the structures established.

267. The generation of adequate funds will be a major problem. Therefore activities should emphasise the use of traditional techniques and local materials. The identification and adevelopment of local medicinal plants is very important in this context, since they have a great potential for supplementing and substituting imported manufactured conventional pharmaceuticals.

268. The indigenous (native) doctors and healers will have to be encouraged to develop their techniques which can be used to produce inexpensive drugs and other treatments. Local industries should be assisted to undertake the design and manufacture of hospital and laboratory equipment from local materials.

269. Further illustrations of how viable industries can be set up in this sector can be found under the section entitled Chemical Industry.

270. Co-operation will be needed at the subregional and regional levels in the establishment of local markets which should carry inexpensive drugs, etc. Assistance can be sought from organizations like ECA, UNIDO and WHO in finding solutions for technical problems that arise.

Mineral Resources

271. "With about 30 per cent of the world's mineral resources located in Africa, there is no doubt that if handled properly these resources could do for the continent (as far as acquisition of physical wealth) what oil has done for the countries of the Middle East. But in order to make this dream come true the producer countries must co-ordinate their efforts in the battle to exercise control over their wealth..... Basically, Africa still remains the supplier of raw materials (in this case, mineral resources) to the more developed nations of the world. In other words, the mineral resources of Africa are taken in ever-increasing quantities by foreign multinational companies who receive large profits from this activity".58/

272. The foreign multinational companies exploit this resource in a manner which takes little or no account of the needs of the host economy; because of their easy access to financing, expertise in technology, managerial knowledge, and experience in exploration, evaluation, extraction and processing of mineral resources, capital intensive techniques are invariably used at high cost to the host country concerned in situation often requiring extensive use of labour.

273. But little, if any, effort is made by the host countries to regulate or correct this situation primarily because they lack information on which to base the required decisions. Yet, with the increase in complexity of new equipment, have come more specialized methods of mine development. These sophisticated designs and construction methods are made available in small packages.59/

274. Because of the high concentration of only a few specialized firms in the mining industry, and the global standardization of operations, such packages are released only under license or other arrangements with restrictions on their manner of use - making it difficult for African countries to unpackage the technology or to search for other alternatives.

275. To compound the situation, research and development work is usually undertaken in the metropolitan centres of such companies so that newly developed skills, experience and knowledge required to design and operate mines are used to reinforce their control on world mineral resources development.

276. Many African countries unfortunately have no detailed knowledge of their natural resource base, which in turn means that no provisions can be made in policy terms for training the range and quality of manpower and providing the institutions required to exploit them. Thus, they can hardly be in any position to negotiate with private mining and mineral exporting companies.

58/ Africa Magazine No. 79, March 1978.

59/ Africa Undermined, by G. Lanning with M. Mueller, Chap. 15 Mining in Africa Today, Penguin Books, 1979.

277. Yet African countries continue to talk about sovereignty over their natural resources. But sovereignty over natural resources cannot be established when resource bases are either unknown or merely suspected to exist, and even when known, understood in hazy terms.

278. However, most governments negotiate the ownership of 51 per cent or better of the assets of a foreign mining company in one or two areas of mineral resources in what they loudly proclaim as a move to control policy-making to ensure that additional benefits would accrue from the mining operations. But ownership does not guarantee control of policy-making and its implementation.

279. The mines continue to operate as independent enclaves as usual in many countries, transferring hardly any skills, using their foreign technical, managerial and financial expertise with hardly any linkages to the rest of the economy, and with the Governments remaining ignorant of other potential sources of minerals, especially the resources of the sea, until the foreign mining companies develop an interest in them.

280. Another imminent problem for African countries, is the slowly developing trend among transnational companies to shift their operations in Africa from the exploration and evaluation of new sources to extraction and processing of minerals from open cast mines instead of underground ones. The reason given for this shift is prohibitive capital investments on the exploration and evaluation phases of mining operations. But it seems more likely that with the recent development of plate tectonics and its combination with systematic exploration techniques to locate possible sources of mineral resources, these companies are now concentrating on the search for new sources of mineral resources in their metropolitan centres.

281. But the enormous mineral potential of Africa has to be explored and developed. Action should be initiated by African countires in the face of all these difficulties to develop capabilities necessary for the exercise of sovereignty over mineral resources. In this context, top priority should be given to formulating an effective national mining policy advocating the provision of facilities to enable the countries of Africa to have inter alia detailed and thorough knowledge of their mineral resource base through the establishment of national/multinational mining corporations 60/ capable of undertaking geological, and mineral exploration, mapping, prospecting, evaluation, extraction and marketing of minerals in general or of negotiating satisfactory agreements for any of these functions with foreign companies.

60/ This approach was taken by Algeria, Japan, India, Indonesia, South Africa etc.; the Iranian Oil Company entrusted with the development of manpower in the oil industry followed this route also to achieve the goal of training manpower in chemical analysis, foundry technology, personnel management, etc., all of which satisfied the needs of not only the oil industry's requirements but also that of the railways and other engineering works.

"To this end, the training of African geologists, geochemists, geophysists, (Cartographers, remote sensing specialists), prospectors, laboratory personnel, mining and processing engineers, (marketing specialists) as well as generally skilled labour is of paramount importance." 61/ This way the stronghold of technological dependence will be drastically slackened and controlled, if not entirely eliminated.

282. Many African countires may, of course, partly disagree with the above proposal and simply claim that costs especially those for extraction and refining are prohibitive because of the complex technologies involved. But the decisions as to what scale of operations to adopt at the national level necessarily rests with African governments.

283. Attention should be directed to the fact that for many countries, small scale mining 62/ of metallic and construction minerals can be undertaken at reasonable and sustainable costs at the same time that large scale mining on a joint venture basis or some other kind of arrangement is progressing on favourable terms to the host country. Each country is free to make its own choice depending upon its financial resources and the extent of its commitment to the fact that a comprehensive knowledge of its mineral resource base is essential for long range planning of socio-economic development.

284. The development of mineral resources involves the performance of activities and operations - which may be categorized into the following stages:

(a) exploration;

(b) evaluation;

(c) extraction;

(d) processing

all of which require technological inputs in the form of know-how and know-why, equipment and information.

285. A country's major goal in mineral resource exploitation should be to establish detailed knowledge of the extent and potential of its mineral resource base by acquiring the indigenous capability to manage established institutions, to co-ordinate the four stages of operations given above, to generate new technology and adopt imported technology.

61/ Words in brackets are not in quotation, which is taken from Matters Arising from the First Session of Natural Resources Surveys, p.7. Second Session Committee on Natural Resources, E/C.7/27/Add.1, Nairobi, Kenya, 31 January to 11 February 1972.

62/ For definition, see Small-scale mining in the developing countries, ST/ECA/155, United Nations, New York, 1977 p.20. The following minerals are amenable to small-scale mining — Iron, copper, tin, lead, zinc, gold, chromium, silver, asbestos, sulphur, coal etc., and soapstone, clay, gypsium stone etc.

286. An illustration of the nature of scientific and technological capabilities needed is presented below:

Exploration and Evaluation

287. Exploration is the initial step undertaken in the development of mineral resources, since eventual production of the minerals depends on the successful search for valuable mineral deposits. Once the deposit has been located it has to be evaluated in respect of size, grade, physico-chemical, geological and other characteristics in order to determine methods of extraction and processing. Technologies currently available for mineral resource exploration and evaluation are many and varied. They range from highly sophisticated methods and techniques to small and medium-scale techniques requiring mobilization of mass participation. The mix of techniques utilized by any one country will depend on the mining policy adopted by the country and the availability of human and other resources to carry out the necessary tasks.

288. A very high level of specialisation in several disciplines is required to carry out exploration work, involving the collection and interpretation of necessary data, and preparation of maps from which relevant information can be extracted.

289. This involves activities requiring remote sensing techniques including aerial photography satellite imagery, recordings of airborne radar, photo-interpretation, geodesy etc., combined with those of cartography embracing ground surveying and sampling using modern methods of field surveys, (e.g., plate tectonics, geochemical and geophysical methods), advanced methods of rapid and accurate map compilation and reproduction, information for locating and assessing mineral soil and forest resources etc.

290. This scientific and technical data collection requires multi-disciplinary action. Sectoral specialists should, after the survey, collectively prepare a document describing the composition of the elements in the environment, their state, structure and organization, their formation and origin, and forcasting their future, and evaluating their potential for development. All this information should be presented in such a form that they are comprehensible to decision makers while retaining their scientific value.

291. There is a need therefore to establish institutions at the national and regional levels to train manpower in the various relevant scientific and technological disciplines. Within this context, adequate use should be made of the existing Regional Cartographic and Remote Sensing centres established under the aegis of ECA at Ile-Ife (Nigeria), Ouagadougou (Upper Volta), Nairobi (Kenya) and Kinshasa (Zaire). In order for the African region to benefit from the data collected on the analysis and exploration of wet forests and in mineral resources exploitation for example, five training and user assistance centres located at Ouagadougou, Nairobi, Kenshasa, Ile-Ife and Cairo (Egypt) have been established.

292. High level training in fields such as geophysics, geodesy and photogeology can also be obtained at post graduate and sometimes at undergraduate level by effecting necessary revision of existing curricula in African higher institutions of learning and by using facilities in Third World Countries e.g. Bolivia, Columbia. 93/

293. Participation of African nationals in conferences and technical meetings to keep abreast of developments in the field should also be given high priority. Due cognizance should also be taken of the services to be rendered by a national or regional organization for mining research and development in the development of appropriate technologies and adaptation of imported technologies for exploration and evaluation of mineral resources.

294. Efforts should also be made to organize mass participation when possible in the utilisation of small and medium-scale operations - searching the ground for valuable mineral alluvial slopes, geochemical exploration using simple and inexpensive soil and water testing kits for use by an unskilled prospector, and drilling to recover samples for testing.

Extraction and Processing

295. When the mineral find has been tested and proven to be valuable, investments have to be made to develop and "work the mine" for its yields, after which the product must be refined or processed - i.e., the removal of impurities from the mined ore.

296. There are several extraction methods, available depending on the size and nature of the ore deposit (e.g. whether it is a metallic or industrial mineral deposit) and whether it is open cast or underground. Some of these methods are artisanal or primitive placer mining by hand in the form of dish or pan, jigging by gravity methods, dredging, open pit mining, quarrying etc., and sophisticated methods of underground mining and refining in the form of gravity methods.

297. The multinationals are gradually shifting from underground to surface (open cast) mining requiring very complex technologies for extraction and processing certain mining industries such as aluminium and nickel, for which they take out patents. But such technologies as has been explained before are not necessarily the most appropriate for the conditions under which they are utilized.

298 The techniques used in the mining of iron ore and coal on the other hand are not so sophisticated technologically, therefore the big multinationals are not so interested in such areas.

93/ For further information, see Directory of Services for Technical Cooperation Among Developing Countries, UNDP document, No. 1, June 1977, pp. 17-22, 58.

299. African governments should conduct investigations to obtain information about both types of industries and try to develop local methods or search for old techniques which can be utilized inexpensively, while also training local people through joint ventures to use the not-so-sophisticated techniques.

300. Experience in the design and operation of processing plants is hardly available in any African country. Know-how can be introduced in this area by the secondment of employees in the parent firms to work in the local subsidiaries and train indigenes. Agreements could also be contracted between host governments and the multinational companies to provide access within an agreed time span to the commercial processes and technical information including future development trends.

301. Training of manpower in the various fields of extraction and refining methods will eventually produce for the country engineers and scientists knowledgeable and experienced in mineral extraction and processing. This training could, of course, be offered by the local subsidiaries of multinationals under the watchful eye of the national mining corporation or by the national mining corporation itself.

302. It is therefore necessary for African governments to establish institutions for training in the managerial, marketing and other aspects of mining; institutions for the development and adpatation of technology for extraction and refining and for standardization. The physical infrastructure for transporation and distribution of extracted and refined minerals should also be developed.

303. Assistance could be sought from institutions such as the East African Minerals Resources Development Centre in Dodoma (Tanzania), the ECA, UNIDO, ARCT, ARCEDI, ARGO, ESARIPO, OAPI international organizations and UN agencies.

Resources of the Sea

304. The resources which the sea has to offer in all the sectors previously mentioned should also be explored and exploited by African countries using some of the techniques of exploration and exploitation already discussed.

305. The seas have plants, from which drugs can be extracted, surfacial and placer deposits (e.g., sand and gravel, phosphorite, iron ores, maganese nodules, tin, gold etc.), and disolved chemicals (e.g., salt, magnesium compounds). The energy of the tides, waves and ocean currents have also to be harnessed. 64/

306. In order to successfully exploit these resources it will be necessary for off-shore structures such as mooring and loading buoys, terminals, artificial islands, undersea ports, pipelines, etc. to be constructed.

64/ See "Marine Resources and Ocean Space: An Inductive Approach to Technology Transfer" by Ocean Economics and Technology Office, UN in Technology and Development, UNITAR NEWS Vol.6, No.4, 1974.

307. To enable African governments to exercise sovereignty over the resources of the sea, training of manpower in the areas just mentioned will have to be undertaken e.g., design engineers for off-shore structures subject to wave and current forces, underwater for[illegible]dies for location and identification of mineral deposits and for fishery resources. For resource exploration, the capability to survey and map effectively the coastal area and the ocean floor is required.

308. Such activities will of course at some stage be undertaken jointly with transnational corporations. It would be wise therefore for legal machinery and institutional and physical infrastructure with adequate linkages to be established so that any exploitation of the resources of the sea is undertaken with indigenous control and full participation and in an environment in which indigenous manpower development, technology development and institutional development incorporating forward and backward linkages with the rest of the economy will result.